SOIL SURVEY OF
BANDERA COUNTY, TEXAS

ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated April 1977. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1960-69. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Bandera Soil and Water Conservation District.

Cover: Area of Tarrant soils, undulating, where brush has been controlled in strips. The remaining cover is ample for deer.

HOW TO USE THIS SOIL SURVEY

This soil survey contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Bandera County are shown on the detailed soil map at the back of this publication. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site and pasture and hay group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites.

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Use of the Soils in Town and Country Planning."

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers to Bandera County may be especially interested in the "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

Contents

Issued April ----------1977

SOIL SURVEY OF BANDERA COUNTY, TEXAS

By James L. Hensell, Glen W. Dittmar, and Frank Taylor, soil scientists, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station

BANDERA COUNTY is in the south-central part of Texas in the Edwards Plateau Land Resource Area (fig. 1). The county is hilly, and it has canyons, valleys, and plateaus. The total area of the county is 768 square miles, or 491,520 acres. Bandera County is roughly rectangular in shape. It is approximately 48 miles from east to west and 19 miles from north to south. The average annual precipitation is approximately 29 inches. The largest amounts of rain occur in April, May, June, and September.

In Bandera County, about 443,300 acres is used for range, 33,400 acres for farms, and 11,876 acres for other purposes. Inland water (Medina Lake) makes up 2,944 acres. Many creeks are tributaries of the Medina and Sabinal Rivers, which are the main streams in the county.

The major livestock products are beef, mutton, wool, and mohair. Winter small grain, grain sorghum, and hay are the major crops. Many ranchers engage in commercial hunting enterprises. Deer and turkey are plentiful. Other commercial enterprises are guest ranches, church camps, a purse factory, and an electric cooperative. A few ranches are now in real estate developments sold in small acreages for ranchettes and homesites.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Bandera County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many characteristics of the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Anhalt and Doss, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a

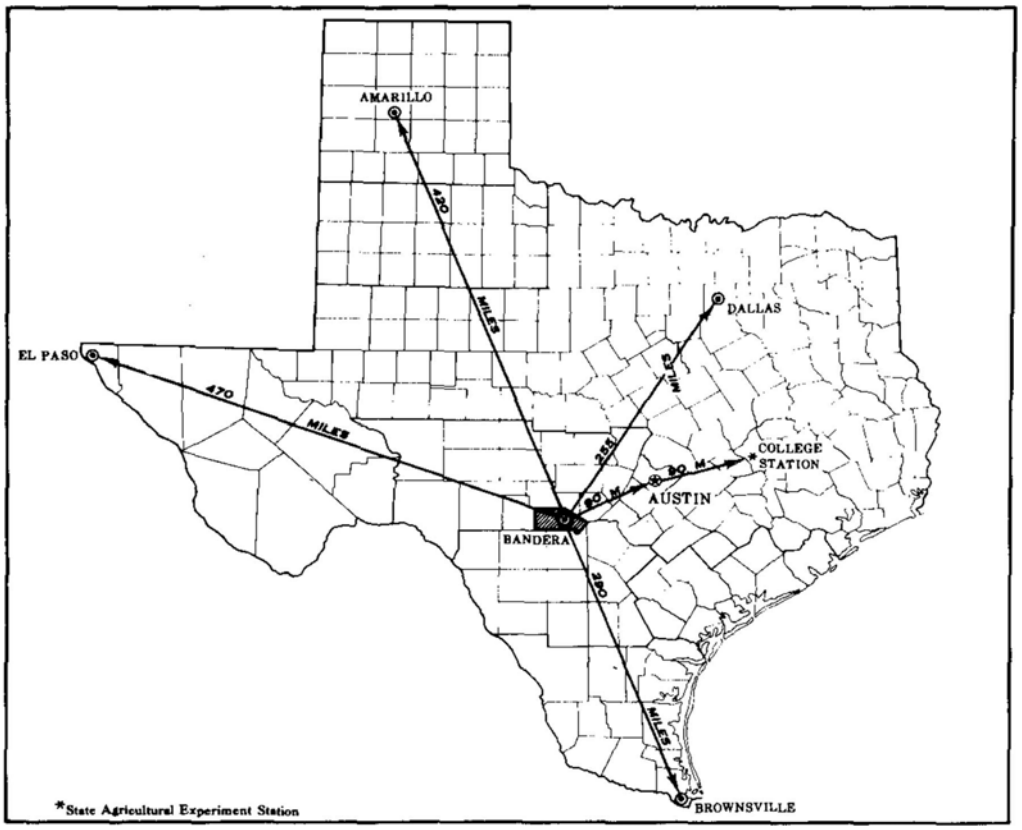


Figure 1.—Location of Bandera County in Texas.

feature that affects management. For example, Krum silty clay, 1 to 3 percent slopes, is one of several phases within the Krum series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of some other kind of soil that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Such mapping units are shown on the soil map of Bandera County as soil associations and are mapped with less detail.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly. The name of an association consists of the names of the dominant soils, joined by a hyphen. Tarrant-Brackett association, steep, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are described in the survey, but they are called land types and are given descriptive names. Rock outcrop is a land type in Bandera County.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Bandera County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. A particular soil may be present in more than one association, but in a different pattern and proportion.

A map showing soil associations is useful to those who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a specific kind of land use. Such a map is a useful general guide in managing a watershed, an area of range, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not suitable for detailed planning of a small tract of land, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The four soil associations in Bandera County, which are shown on the colored map at the back of the survey, are described on the following pages.

1. Tarrant-Brackett association

Undulating to steep, very cobbly clayey to loamy, shallow to very shallow soils; on uplands

This association occupies undulating foot slopes, steep hillsides, and narrow hilltops. It makes up about 72 percent of the county.

The association is about 42 percent Tarrant soils, 25 percent Brackett soils, and 33 percent Rock outcrop and other soils. The other soils are in the Frio, Denton, Krum, Nuvalde, and Doss series. All of these soils formed over limestone.

Tarrant soils have a surface layer of very dark grayish-brown very cobbly clay that is about 7 inches thick over hard limestone. The soils range from 4 to 14 inches in thickness. Slopes range from 1 to 8 percent on low hills and in fringe areas of the plateau but are as much as 45 percent on hillsides. Tarrant soils occupy the upper 50 to 75 percent of hillsides in the western part of the county, and from 25 to 50 percent in the eastern part of the county.

Brackett soils are on undulating foot slopes and steep hillsides. They have a surface layer of light brownish-gray, calcareous clay loam about 6 inches thick and a lower layer of pale-yellow, calcareous clay loam about 8 inches thick. The underlying material, extending to a depth of 40 inches, is yellow clay loam marl.

Limestone crops out both in the undulating areas and on the steep hillsides. The minor soils are in the narrow valleys and drainageways.

This association is in range. The major soils are not suited to cultivated crops, hay, or pasture, because they are too stony, too steep, and too shallow. They are suited to range and wildlife habitat. The minor soils have potential for cultivation, but the areas are too small for farming to be feasible.

2. Frio-Krum-Nuvalde association

Nearly level to gently sloping, clayey, deep soils; on bottom lands and terraces and in valleys

This association occupies narrow, nearly level to gently sloping valleys of the major streams (fig. 2). It makes up about 15 percent of the county. The major soils formed in calcareous alluvium.

The association is about 28 percent Frio soils, 27 percent Krum soils, 11 percent Nuvalde soils, and 34 percent other soils. The other soils are in the Denton, Karnes, Brackett, Doss, and Orif series.

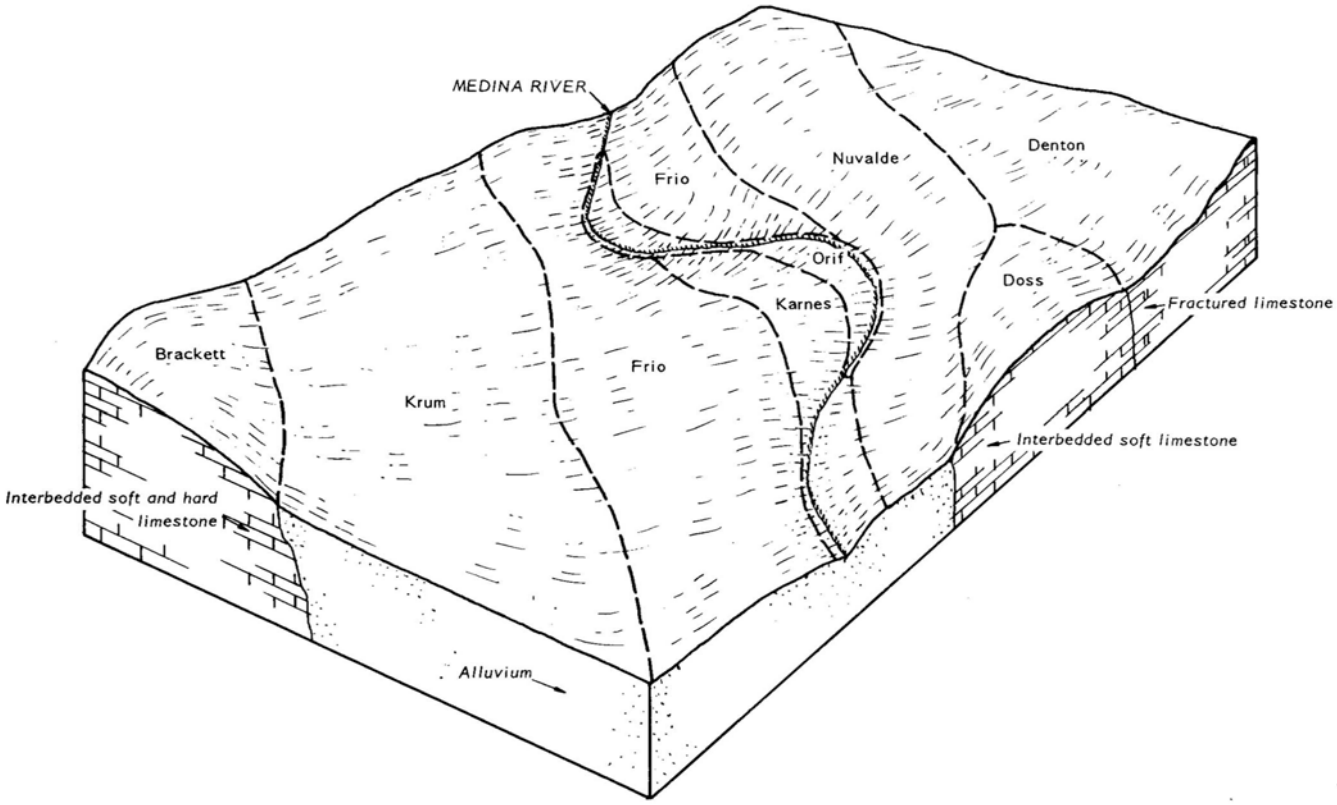


Figure 2.—Pattern of soils in association 2, and the relationship of soils to underlying material.

Frio soils have a surface layer of very dark gray, calcareous silty clay about 26 inches thick and a lower layer of dark-brown silty clay about 11 inches thick. The next lower layer is light-brown, calcareous clay loam about 33 inches thick. Frio soils are near stream channels.

Krum soils have a surface layer of dark-gray, calcareous silty clay about 28 inches thick and a yellowish-brown lower layer about 32 inches thick. Krum soils are in narrow valleys drained by rivers and their tributaries.

Nuvalde soils have a surface layer of dark-brown, calcareous silty clay about 10 inches thick and a lower layer of reddish-brown, calcareous silty clay about 24 inches thick. The underlying material, extending to a depth of 60 inches, is reddish-yellow clay loam. Nuvalde soils are on old terraces above flood plains.

Approximately half of this association is cultivated. The soils are suited to crops, hay, and pasture, and to range and wildlife habitat.

3. Anhalt-Denton association

Nearly level to gently sloping, clayey, moderately deep soils; on uplands

This association occupies nearly level to gently sloping uplands (fig. 3). It makes up about 11 percent of the county.

The association is about 38 percent Anhalt soils, 38 percent Denton soils, and 24 percent other soils. The other soils are in the Doss, Krum, and Tarrant series.

Anhalt soils have a surface layer of dark reddish-brown, neutral clay about 28 inches thick. The underlying material is fractured limestone.

Denton soils have a surface layer of dark grayish-brown, calcareous silty clay about

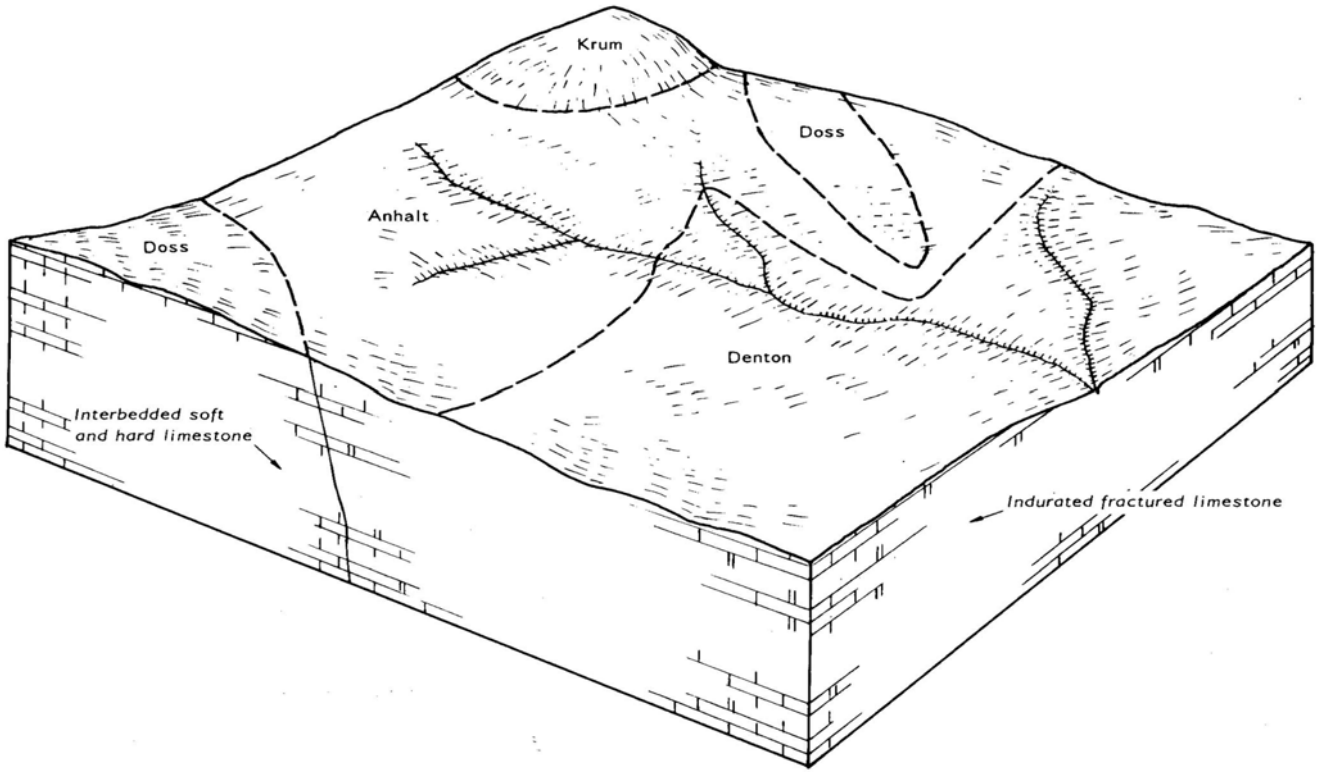


Figure 3.—Pattern of soils in association 3, and the relationship of soils to underlying material.

8 inches thick. The next lower layer is very dark grayish-brown clay about 11 inches thick. Below this is brown silty clay about 4 inches thick. The next lower layer is light yellowish-brown silty clay about 15 inches thick. The underlying material is fractured limestone.

Approximately half of this association is cultivated. The soils are suited to crops and pasture, and to range and wildlife habitat.

4. Spires-Tarrant association

Gently undulating to undulating, loamy to very cobbly clayey, very shallow to moderately deep soils; on uplands

This association occupies gently sloping uplands (fig. 4). It makes up about 2 percent of the county.

The association is about 75 percent Spires soils, 18 percent Tarrant soils, and 7 percent Rock outcrop and other soils.

Spires soils have a surface layer of reddish-brown loam about 6 inches thick. The next layer is dark-red clay about 22 inches thick. The underlying material is limestone.

Tarrant soils have a surface layer of very dark grayish-brown very cobbly clay about 7 inches thick. The underlying material is fractured, indurated limestone bedrock.

This association is in range. Only a few 3- to 5-acre plots, generally unfenced, are planted to small grain for deer. The soils as a whole are too gravelly and stony for farmland, but are well suited to range and wildlife habitat. The Spires soils of this association are suited to pasture and hay.

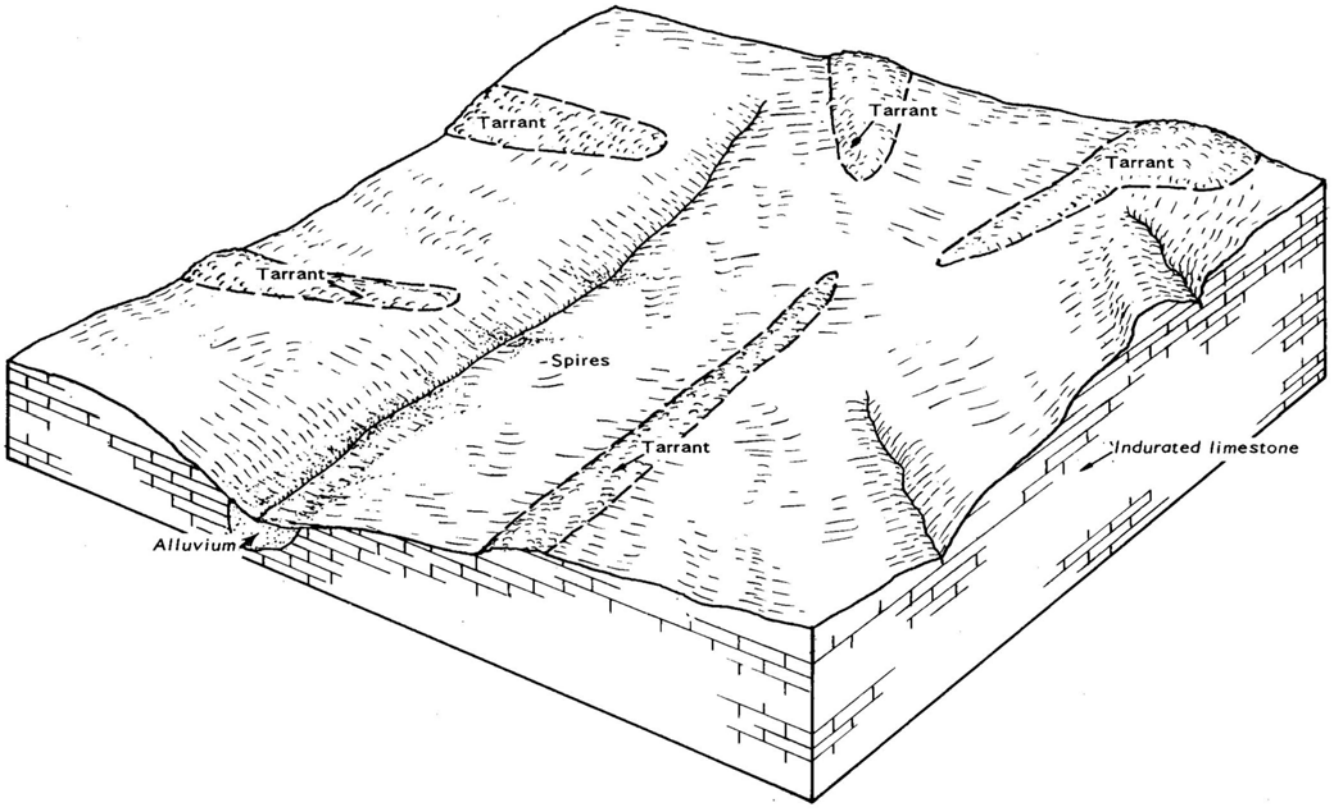


Figure 4.—Pattern of soils in association 4, and the relationship of soils to underlying material.

Descriptions of the Soils

This section describes the soil series and the mapping units in Bandera County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a dry soil.

As mentioned in the section “How This Survey Was Made,” not all mapping units are of a soil series. Rock outcrop, for example, does not belong to a soil series, nevertheless it is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map at the back of this survey. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page on which each capability unit, range site, and pasture and hay group is described can be found by referring to the “Guide to Mapping Units” at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).

Anhalt Series

The Anhalt series consists of moderately deep, noncalcareous, clayey soils that contain cracks when dry and are underlain by limestone bedrock. These soils are nearly level to gently sloping and occupy uplands. The soil surface is slightly wavy.

In a representative profile, the surface layer is dark reddish-brown clay about 12 inches thick. The next layer is dark reddish-brown clay about 16 inches thick. The underlying material is hard limestone bedrock at a depth of about 28 inches.

Anhalt soils are well drained. Runoff is slow, and permeability is very slow. The available water capacity is moderate.

These soils are suited to crops, hay, pasture, and range.

Representative profile of Anhalt clay, 0 to 2 percent slopes, 2 miles east of the junction of State Highway 16 and Farm Road 689 in Bandera, then 50 feet north of fence in a previously cultivated field.

Ap—0 to 4 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/3) moist; weak, fine, angular blocky structure; very hard, very firm; common roots; few chert pebbles; neutral; abrupt, smooth boundary.

A1—4 to 12 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/3) moist; strong, fine and medium, blocky structure; very hard, very firm; shiny faces on peds; few roots between peds and growing through them; few chert particles; neutral, gradual, wavy boundary.

B2—12 to 28 inches, dark reddish-brown (5YR 3/4) clay, dark reddish brown (5YR 3/4) moist; strong, medium and coarse, blocky structure; very hard, very firm; few roots between peds and growing through them; many, prominent, intersecting slickensides; few wedge-shaped parallelepipeds below a depth of 20 inches; few chert particles; neutral; abrupt, irregular boundary.

R—28 inches, indurated fractured limestone; reddish-brown clay in crevices.

The soil ranges from 20 to 40 inches in thickness over indurated bedrock. On the surface and in the soil, the amount of pebble- and cobble-size fragments of limestone and chert ranges from a few to as much as 20 percent, by volume. The clay content ranges from 60 to 80 percent. When dry, the soil has cracks that are 0.5 to 2 inches wide. Reaction ranges from slightly acid to mildly alkaline.

The A horizon is dark reddish gray, dark reddish brown, reddish brown, or dark brown. It ranges from 4 to 20 inches in thickness. In most places, the B horizon is dark reddish brown, reddish brown, or dark reddish gray, but in a few places it is red or dark red in the lower part. It ranges from 16 to 28 inches in thickness.

Anhalt clay, 0 to 2 percent slopes (AN).—This soil is on uplands. The dominant slope is about 1 percent. A few areas have a slightly concave surface. Mapped areas are oblong in shape and range from 30 to 400 acres in size.

Included with this soil in mapping are areas of Denton and Krum soils that are in narrow strips of 1 to 5 acres in size and that make up 10 to 15 percent of many mapped areas and areas of Tarrant soils that are on small, crescent-shaped knolls of less than 3 acres in size and that make up as much as 10 percent of some mapped areas.

This soil is well suited to such crops as small grain and sorghum. The available water capacity is moderate and enables plants to survive short periods of below-average precipitation. The clay surface has good tilth, but the soil should be tilled only at optimum moisture content. Water erosion is a moderate hazard. Terracing and farming on the contour help control water erosion. Using a cropping system that includes high-residue, soil-improving crops frequently enough and leaving the residue on the surface help to maintain tilth, conserve moisture, and improve yields. (Capability unit IIIe-1; Redland range site; pasture and hay group 7A)

Brackett Series

The Brackett series consists of shallow, calcareous, loamy soils that are underlain by chalky limestone. These soils are undulating to steep and are on uplands.

In a representative profile, the surface layer is light brownish-gray clay loam about 6 inches thick. The next layer is pale-yellow clay loam about 8 inches thick. The underlying material is yellow, weathered marl that has a texture of clay loam.

Brackett soils are well drained. Runoff is rapid, and permeability is moderately slow. The available water capacity is low.

These soils are suited to range and wildlife habitat.

Representative profile of Brackett clay loam, in an area of Brackett association, undulating, 0.9 mile northwest of the junction of State Highway 16 and Farm Road 689 northwest of Bandera, then approximately 4.1 miles northwest on Ridge Route Road, then 50 feet south in range.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure; hard, firm; common roots; about 5 percent, by volume, is small, hard particles of limestone, mainly less than 5 millimeters in diameter; calcium carbonate equivalent is 74 percent; calcareous; moderately alkaline; clear, smooth boundary.

B2—6 to 14 inches, pale-yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/4) moist; moderate, fine, subangular blocky structure; hard, firm, slightly sticky when vet; common roots; few soft masses of calcium carbonate and hard pebbles of calcium carbonate, as much as 1/2 inch in diameter; calcium carbonate equivalent is 78 percent; calcareous; moderately alkaline; clear, smooth boundary.

C—14 to 40 inches, yellow (2.5Y 7/6) clay loam marl, pale yellow (2.5Y 7/4) moist; rock structure and original bedding planes evident; few roots between cleavage planes; common hard and soft pebbles of limestone, mainly less than 1/2 inch in diameter; calcium carbonate equivalent is 80 percent; calcareous; moderately alkaline.

The solum ranges from 10 to 20 inches in thickness. The calcium carbonate equivalent ranges from 40 to 80 percent for the profile. The content of coarse fragments in the profile ranges from a few to as much as 30 percent.

The A horizon is light-gray, light brownish-gray, pale-brown, or light yellowish-brown clay loam, loam, or gravelly loam. It ranges from 5 to 10 inches in thickness.

The B horizon is grayish-brown, very pale brown, pale-yellow, or light-gray clay loam, silty clay loam, or gravelly loam. It ranges from 5 to 10 inches in thickness. The clay content ranges from 22 to 35 percent.

Brackett association, undulating (BKX). —This association is on uplands. The soils are undulating, and slopes range from 1 to 8 percent. Mapped areas are irregular or oblong in shape and range from 50 to 500 acres in size. Brackett soil makes up 60 to 90 percent of all mapped areas. This soil has the profile described as representative for the series.

Included in mapping are narrow bands of bedrock outcrop, narrow bands of Doss clay or Denton silty clay, and, on the somewhat rounded caps of low hills, areas of Tarrant stony clay. Any one included soil may make up as much as 20 percent of a given area mapped as this association, and all the inclusions make up as much as 40 percent of a few mapped areas.

The soils in this association could be mapped separately, but separating them is not justified because their use and management are similar.

The soils in this association are used for range and wildlife habitat. Water erosion is a moderate hazard where grass cover is sparse. The surface crusts if it is left unprotected. A cover of deep-rooted grasses helps control surface crusting and erosion. (Capability unit VIs-1; Adobe range site; not in a pasture and hay group)

Brackett-Rock outcrop association, hilly (BRX).—This association is on hillsides. Slopes range from 10 to 30 percent. The association is about 63 percent Brackett soils, 27 percent Rock outcrop, and 10 percent other soils. Mapped areas are oblong to roughly circular in shape and range from 100 to 800 acres in size. In some places they cover an entire hill.

Typically, this Brackett soil has a surface layer of light-gray gravelly loam 5 inches thick. The next layer is light-gray clay loam, 6 inches thick, that has an estimated clay content of 30 percent. The next layer is interbedded chalky limestone and marl.

Rock outcrop is massive limestone in bands that are roughly on the contour and that give the landscape an appearance of stairsteps.

Included in mapping are small oval areas, 5 to 20 acres in size, of Tarrant clay on side slopes; narrow bands, on the contour, of Brackett soils that have slopes of less than 10 percent or more than 30 percent. Also included are Doss clay and Krum silty clay in irregularly shaped areas of 10 to 20 acres. These inclusions make up 5 to 15 percent of most areas mapped as the association.

The soils in this association could be mapped separately, but separating them is not justified because their use and management are similar.

The soils of this association are used for range and wildlife habitat. The hazard of erosion is high. Conservation treatment consists of maintaining a cover of native grasses to keep erosion to a minimum. (Capability unit VIIs-2; Steep Adobe range site; not in a pasture and hay group)

Denton Series

The Denton series consists of moderately deep, calcareous, clayey soils that are underlain by limestone. These soils are gently sloping and undulating and have convex slopes. They are on uplands.

In a representative profile, the surface layer is dark grayish-brown, calcareous silty clay and very dark grayish-brown clay about 19 inches thick. The next layer is silty clay about 19 inches thick. The upper 4 inches of this layer is brown, and the lower 15 inches is light yellowish brown. Depth to fractured limestone is 38 inches (fig. 5).

Denton soils are well drained. Runoff is medium to rapid, and permeability is slow. The available water capacity is high.

These soils are suited to crops, pasture, range, and wildlife habitat.

Representative profile of Denton silty clay, 1 to 3 percent slopes, 5.9 miles northwest of the junction of State Highway 16 and Farm Road 689 on Farm Road 689, then northeast 600 feet on county road, then 120 feet southeast in a cultivated field.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; very hard, very firm; common fine roots; few small fragments of limestone; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—8 to 19 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; compound, moderate, fine, subangular blocky and granular structure; very hard, very firm; few fine roots; few small fragments of limestone 1/4 inch in diameter; calcareous; moderately alkaline; clear, smooth boundary.

B21ca—19 to 23 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; very hard, very firm; common indurated fragments of limestone as much as 1 inch in diameter; calcareous; moderately alkaline; clear, wavy boundary.

B22ca—23 to 30 inches, light yellowish-brown (10YR 6/4) silty clay, yellowish brown (10YR 5/4) moist; weak, fine, granular structure; hard, very firm; common indurated fragments of limestone as much as 1 inch in diameter; calcareous; moderately alkaline; abrupt, wavy boundary.

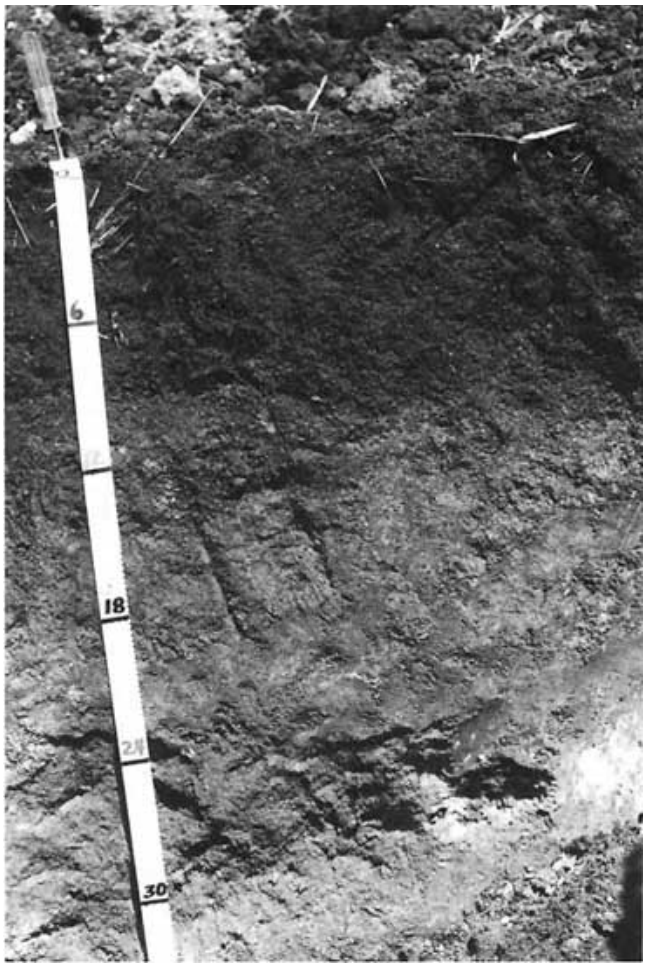


Figure 5.—Profile of Denton silty clay. The dark-colored surface layer is 6 inches thick.

B3ca—30 to 38 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak, medium, subangular blocky structure; firm, sticky; estimated 20 percent of horizon is indurated nodular cobbles and pebbles of limestone that are etched on upper faces and that have thin coatings of calcium carbonate; calcareous; moderately alkaline; abrupt, wavy boundary.

R—38 to 42 inches, fractured limestone.

This solum ranges from 20 to 40 inches in thickness. When dry, the soil has cracks that are 0.3 to 0.5 inch wide and extend to a depth of as much as 20 inches. Fragments of limestone range from 0.5 to 3 inches in diameter and make up 0 to 20 percent, by volume, of the solum.

The A horizon is brown, dark-brown, dark grayish-brown, or very dark grayish-brown silty clay or clay and ranges from 16 to 24 inches in thickness. The upper 8 inches of the A horizon ranges from noncalcareous to calcareous but is moderately alkaline. Calcium carbonate content ranges from 12 to 26 percent.

The B horizon is dark-brown, brown, or light yellowish-brown silty clay or clay and ranges from 0 to 19 inches in thickness. Calcium carbonate content ranges from 47 to 49 percent.

Denton silty clay, 1 to 3 percent slopes (DE).—This soil is on uplands. Mapped areas are rectangular to oval in shape and range from 20 to 150 acres in size. The

dominant slope is about 2 percent. This soil has the profile described as representative for the series.

Included with this soil in mapping are long, narrow bands of Krum silty clay and areas of Doss clay on narrow ridgetops. These included areas range from 1 to 5 acres in size and make up less than 10 percent of the average area mapped as this Denton soil.

This soil is used for cultivated crops and tame pasture. It responds to good management. Water erosion is a moderate hazard. Adapted crops are small grain, grain sorghum, sudangrass, or similar hay crops and clover. All crops are used mainly for grazing or hay. Conservation treatment consists of leaving crop residue on the surface to control surface crusting and to maintain soil condition. Terraces and contour farming help control water erosion. Fertilization may be needed. (Capability unit IIe-1; Deep Upland range site; pasture and hay group 7C)

Denton silty clay, 3 to 5 percent slopes (DL).—This soil is on uplands. Mapped areas are oblong to rectangular in shape and range from 25 to 100 acres in size. The dominant slope is about 3 1/2 percent.

Typically, the surface layer is very dark grayish-brown silty clay about 21 inches thick. The next layer is brown silty clay, 3 inches thick, and is an estimated 15 percent fragments of limestone 1/2 to 2 inches in diameter. The next layer is fractured limestone.

Included with this soil in mapping are small areas of Doss clay, Krum silty clay, Tarrant clay, and Brackett clay loam. These included areas are 1 to 5 acres in size.

This soil is used for crops, pasture, range, and wildlife habitat. Crops are small grain and hay crops that are used for grazing and hay. The hazard of water erosion is high. Conservation treatment consists of using, with adequate frequency, high-residue, soil-improving crops; leaving the crop residue on the surface; fertilizing; terracing; and contour cultivating. This soil is better suited to broadcast or drilled crops than to most row crops. (Capability unit IIIe-2; Deep Upland range site; pasture and hay group 7C)

Denton association, undulating (DNX).—This association is in broad upland areas at the base of low hills (fig. 6). Mapped areas are irregular to oblong in shape and range from 50 to 400 acres in size. Slopes range from 1 to 8 percent. The association is about 62 percent Denton soils and 38 percent other soils.

Typically, the Denton soils in this mapping unit have a surface layer of dark-brown silty clay 30 inches thick. The next layer is indurated, fractured limestone.

Included in mapping are narrow bands of Anhalt soils 1 to 2 acres in size; narrow bands of Brackett soils that are on the contour, adjacent to hillsides, and 2 to 5 acres in size; bands of Doss soils 50 to 100 feet wide and 1 to 5 acres in size; narrow strips of Krum soils that are near drainageways; and areas of Tarrant soils on low, rounded knolls or in narrow strips less than 5 acres in size. These inclusions make up 10 to 38 percent of most areas mapped as the association.

The soils of this association are used mainly for range. They are also suited to pasture and hay. Because of the slope and the inclusion of shallow soils there are limitations to the use of this soil for cultivated crops. The hazard of water erosion is high, and the maintenance of a good cover of grass is needed. If the soils are cultivated, consideration should be given to using a cropping system that includes, with adequate frequency, high-residue, soil-improving crops and managing the crop residue on the soil surface. Drilled crops that are properly fertilized give better protection than row crops. Terraces and contour farming help to control water erosion in cropped areas. (Capability unit IVe-1; Deep Upland range site; pasture and hay group 7C)

FIgure 6.—Area of Denton association, undulating, that has a good cover of grass.

Doss Series

The Doss series consists of shallow, calcareous, clayey soils underlain by weakly cemented limestone. These soils are gently sloping and have convex surfaces. They are on uplands.

In a representative profile, the surface layer is dark-brown calcareous clay about 7 inches thick. The next layer is about 10 inches thick. The upper 5 inches is brown, calcareous clay and the lower 5 inches is light-brown, calcareous clay loam. The underlying material is weakly cemented limestone.

Doss soils are well drained. Runoff is medium, and permeability is moderately slow. The available water capacity is low.

These soils are suited to crops, pasture, hay, and range.

Representative profile of Doss clay, 1 to 5 percent slopes, 0.9 mile northwest of the junction of State Highway 16 and Farm Road 689 in Bandera, then north-northwest 1.8 miles on Ridge Route Road, then 60 feet north of fence in a cultivated field.

Ap—0 to 7 inches, dark-brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; hard, firm; few roots; common fine limestone fragments, a few as much as 1/4 inch in diameter; calcareous; moderately alkaline; calcium carbonate equivalent is 34 percent; abrupt, smooth boundary.

B21ca—7 to 12 inches, brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) moist; strong, fine, subangular blocky and granular structure; hard, firm; common, fine, hard and soft calcium carbonate particles and fragments, mainly less than 1/4 inch in diameter; calcium carbonate equivalent is 49 percent; calcareous; moderately alkaline; clear, wavy boundary.

B22ca—12 to 17 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/5) moist; in seams and crevices of soft, white, partly weathered limestone; weak, fine, granular structure; slightly hard; firm; few roots; calcium carbonate

equivalent is 62 percent; calcareous; moderately alkaline; clear, wavy boundary.

C—17 to 30 inches, white, weakly cemented limestone that can be cut with a spade and that contains thin strata of cemented limestone and pockets of soft chalky marl; calcium carbonate equivalent is 78 percent.

The solum is 11 to 19 inches thick over limestone.

In the A and B horizons, the texture is clay, silty clay, or clay loam; the clay content ranges from 38 to 50 percent; and the calcium carbonate equivalent ranges from 49 to 62 percent. The A horizon is brown, dark grayish brown, very dark grayish brown, or dark brown. It ranges from 7 to 12 inches in thickness. The B horizon is reddish brown, brown, light brown, or yellowish brown. It ranges from 4 to 10 inches in thickness.

Doss clay, 1 to 5 percent slopes (DS).—This soil is gently sloping and is on uplands. The dominant slope is about 2.5 percent. Mapped areas are oblong to rectangular in shape and range from 20 to 300 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Denton silty clay, Brackett clay loam, and Tarrant clay that range from 1 to 5 acres in size and make up as much as 10 percent of some areas mapped as this Doss soil.

This soil is used for crops, pasture, hay, and range. Most of the acreage is used for small grain and hay. Crops grown in cool seasons, such as small grains, are better adapted than crops grown in warm seasons because this soil is shallow.

Water erosion is a moderate hazard. Terracing, contour farming, and management of crop residues on the surface are needed to control erosion, improve or maintain tilth, and increase or maintain crop yields. Drilling crops rather than planting in rows helps control water erosion. (Capability unit IIIe-3; Shallow range site; pasture and hay group 13A)

Frio Series

The Frio series consists of deep, calcareous, clayey soils that formed in alluvium. These soils are nearly level and are on bottom lands near stream channels.

In a representative profile, the surface layer is silty clay about 37 inches thick. The upper 26 inches is very dark *gray,* and the lower 11 inches is dark brown. The underlying material is light-brown clay loam about 33 inches thick. Below this is calcareous alluvial sediment.

Frio soils are well drained. Runoff is slow, and permeability is moderately slow. The available water capacity is high.

These soils are suited to crops, pasture, hay, and range.

Representative profile of Frio silty clay, 10 miles west-northwest of Bandera on State Highway 16 to junction with Farm Road 2828, then 3.2 miles north-northeast on Farm Road 2828, then 50 feet north in a previously cultivated field.

A11—0 to 26 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; strong, fine, subangular blocky structure and strong, medium, granular; hard, firm; few roots; common very fine fragments of limestone; calcareous; moderately alkaline; gradual, wavy boundary.

A12—26 to 37 inches, dark-brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; strong, fine, subangular blocky structure parting to strong, medium, granular structure; hard, firm; few fine fragments of limestone 1/4 inch in diameter; porous; calcareous; moderately alkaline; gradual, wavy boundary.

C—37 to 70 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 4/4) moist; massive; hard, firm; common fine masses of calcium carbonate and few

threads of lime; common fine pores; few kroto-vinas; few thin strata of clay and silty clay loam; calcareous; moderately alkaline.

Depth to gravel, sand, or limestone is 6 to 20 feet. The soil above this depth is 0 to 20 percent gravel, by volume.

The A horizon ranges from 22 to 50 inches in thickness. It is very dark grayish brown, dark brown, very dark gray, dark grayish brown, or grayish brown. Its structure ranges from weak, fine, granular to strong, fine, subangular blocky. Clay content ranges from 35 to 50 percent.

Some of the Frio soils in Bandera County are outside the range defined for the series because their A11 horizon is very dark gray (10YR 3/1) and black (10YR 2/1). This difference does not affect use and management of the soils.

Frio silty clay (FR).—This soil is on bottom lands associated with deeply entrenched stream channels. The dominant slope is about 0.5 percent, but slopes range from 0 to 1 percent. Mapped areas are long and narrow, oblong, or triangular in shape and 25 to 500 acres in size.

In some places narrow areas of Karnes fine sandy loam and fan-shaped areas of Krum silty clay or Nuvalde silty clay are included with this soil in mapping. These included areas range from 1 to 10 acres in size and make up less than 15 percent of the average area mapped as this Frio soil.

This soil is used mainly for cultivated crops. It has good tilth and is easy to cultivate. Plant roots move through the soil easily. Water erosion is only a slight hazard. Flooding occurs about once in 10 to 20 years, and floodwater remains for less than 24 hours. Crops are mainly grain sorghum, small grain, and hay. Some areas are in pasture and hay. Adapted grasses are improved bermudagrass, johnsongrass, and kleingrass. Pecan trees also are well adapted.

This soil should not be plowed or grazed when it is wet. Other practices that help to conserve soil and water are managing crop residues on the surface to protect against surface crusting and using a cropping system that includes crops that produce a large amount of residue. This soil is suited to irrigation, but the supply of water available for irrigation is limited. (Capability unit IIc-2; Bottomland range site; pasture and hay group 1C)

Houston Black Series

The Houston Black series consists of deep, calcareous, clayey soils. These soils are nearly level and are on ancient stream terraces.

In a representative profile, the surface layer is very dark gray clay about 32 inches thick. The next layer is dark-gray clay about 16 inches thick. Below this is light yellowish-brown clay that contains a few weakly cemented concretions of calcium carbonate and a few concretions of ferromanganese and is about 12 inches thick. The underlying material is very pale brown clay that extends to a depth of 72 inches (fig. 7).

Houston Black soils are moderately well drained. Runoff is slow, and permeability is rapid when the soils are dry and cracked, but very slow when the soils are moist. The available water capacity is high.

These soils are suited to crops, pasture, hay, and range.

Representative profile of Houston Black clay, 1.4 miles west of the junction of State Highway 16 and Farm Road 689 northwest of Bandera, then north 0.25 mile on private road to a highline pole, then 180 feet northwest in a cultivated field.

Ap—0 to 5 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; weak, fine, subangular blocky structure; very hard, very firm; few fine roots; few fine calcium carbonate particles; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—5 to 32 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate, fine, angular blocky structure; few intersecting slickensides below a

depth of 12 inches; very hard, very firm; few fine calcium carbonate particles; calcareous; moderately alkaline; diffuse, wavy boundary.

A12—32 to 48 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; blocky structure; few parallelepipeds and intersecting slickensides; very hard, very firm; few fine calcium carbonate particles as much as 1/4 inch in diameter; calcareous; moderately alkaline; gradual, wavy boundary.

AC—48 to 60 inches, light yellowish-brown (10YR 6/4) clay, light yellowish brown (10YR 6/4) moist; moderate, fine, angular blocky structure; very hard, very firm; few, fine, weakly cemented calcium carbonate concretions and soft masses of calcium carbonate; few weakly cemented ferromanganese concretions; calcareous; moderately alkaline; gradual, wavy boundary.

C—60 to 72 inches, very pale brown (10YR 8/4) clay, very pale brown (10YR 7/4) moist; massive; hard, firm; estimated 20 percent cemented calcium carbonate concretions as much as1/4 inch in diameter; few soft, powdery masses of calcium carbonate.

The solum ranges from 60 to 80 inches in thickness. The gravel content in the soil or on the surface ranges from less than 1 percent to an estimated 10 percent. The clay content ranges from 40 to 60 percent.

The A horizon is dark gray, very dark gray, or black. The AC horizon is grayish brown or dark grayish brown and has shades of pale brown or light yellowish brown in the lower part. The C horizon is light yellowish brown or very pale brown.

Houston Black clay (HO).—Houston Black clay is on ancient stream terraces. Slopes range from 0 to 1 percent. Mapped areas are rectangular to oval in shape and range from 30 to 80 acres in size.

Included with this soil in mapping are soils that are similar to Houston Black soils but that range from 40 to 60 inches in depth. Also included are small areas of Nuvalde soils. These included areas range from 1 to 5 acres in size and make up 1 to 10 percent of the average mapped area of this Houston Black soil.

This soil is used mostly for crops, which are small grain, grain sorghum, and grazing or hay crops. The main management concern is maintaining soil conditions.

Water erosion is a slight hazard. Managing crop residue on the soil surface helps maintain soil conditions. (Capability unit IIw-1; Deep Upland range site; pasture and hay group 7A)

Karnes Series

The Karnes series consists of deep, calcareous, loamy soils. These soils are gently sloping and have convex surfaces. They are on low terraces and bottom lands parallel to stream channels.

In a representative profile, the surface layer is light brownish-gray fine sandy loam about 6 inches thick. The next layer is pale-brown fine sandy loam about 32 inches thick. The underlying material is light brownish-gray loamy sand that extends to a depth of 60 inches (fig. 8).

Karnes soils are well drained. Runoff is slow, and permeability is moderately rapid. The available water capacity is moderate.

These soils are suited to crops, pasture, hay, and range.

Representative profile of Karnes fine sandy loam, 1 to 3 percent slopes, 3.4 miles west of Bandera Courthouse on State Highway 16; then north on private road 0.7 mile, then east 100 feet in a previously cultivated field.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak; granular structure; hard, very friable; common roots; few small pebbles and coarse sand particles; calcareous; moderately alkaline; clear, smooth boundary.

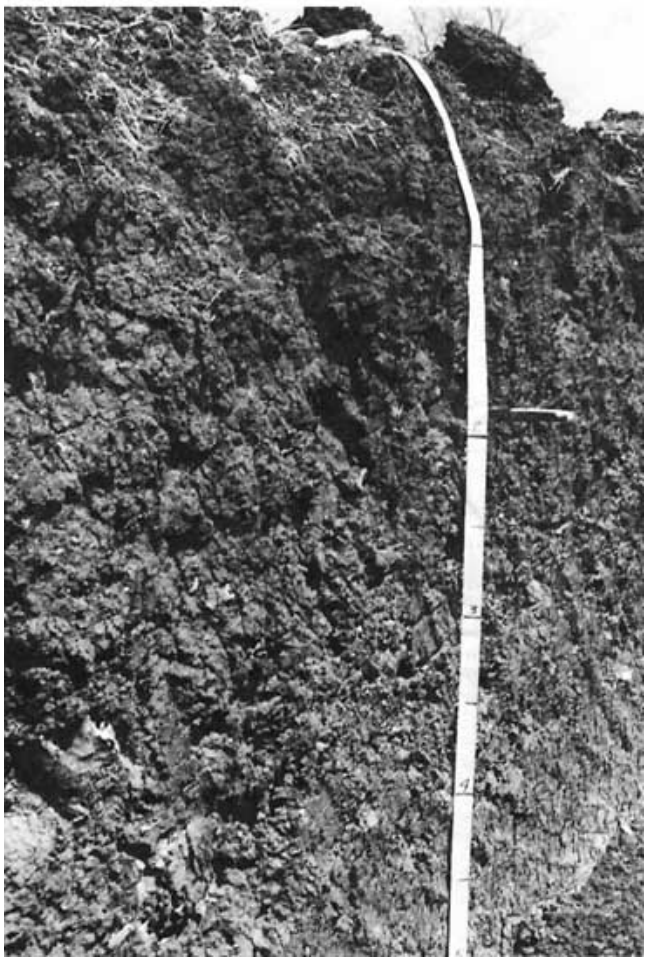


Figure 7.—Profile of Houston Black clay.

B2—6 to 38 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak, fine, granular structure; slightly hard, very friable; few roots; few shell fragments; strata of sand and very fine pebbles; calcium carbonate equivalent is 84 percent; calcareous; moderately alkaline; diffuse boundary.

C—38 to 60 inches, light brownish-gray (10YR 6/2) loamy sand, brown (10YR 5/3) moist; massive; soft; very friable; strata of small pebbles and coarse sand, and a few shell particles; some gravel weakly coated with calcium carbonate; few lime threads; calcareous; moderately alkaline.

The solum ranges from 38 to 50 inches in thickness. Noncarbonate clay content of the 10- to 40-inch layer ranges from 10 to 18 percent. Small limestone fragments range from a few to as many as 5 percent, by volume, and from 1/4 to 1/2 inch in diameter. Calcium carbonate content ranges from 76 to 84 percent.

The A horizon is grayish brown, light brownish gray, brown, light brown, pale brown, or light yellowish brown. It ranges from 6 to 15 inches in thickness.

The B horizon is brown, light brown, pinkish gray, pink, light brownish gray, light gray, pale brown, light yellowish brown, or very pale brown. Lime threads range from a few in the upper part to many in the lower part and gradually increase with increasing depth. The B horizon ranges from 23 to 35 inches in thickness.

Karnes fine sandy loam, 1 to 3 percent slopes (KA).—Karnes fine sandy loam is on narrow, low terraces associated with deeply entrenched stream channels. Mapped areas are long and narrow or fan-shaped and range from 25 to 100 acres in size.

Figure 8.—Profile of Karnes fine sandy loam.

Flooding for periods of less than 24 hours occurs as often as once in 10 years and as seldom as once in 20 years. This soil has the profile described as representative of the series.

Included with this soil in mapping are narrow strips of Karnes soils that have slopes of 0 to 1 or 3 to 5 percent. Also included are long, narrow strips of Frio soils. These included areas range from 1 to 5 acres and make up less than 15 percent of the average area mapped as this Karnes soil.

Karnes soils are used mainly for small grain, grain sorghum, and hay crops, but a few areas are used for hay, pasture, and range. Karnes soils are high in lime, and crops are subject to chlorosis. Maintaining soil condition is also a concern of management. Water erosion is a moderate hazard. Conservation treatment needed consists of managing large amounts of crop residue on the surface to protect the surface from crusting, control erosion, and improve tilth. Fertilizer, especially phosphorus, is needed. (Capability unit IIIs-1; Deep Upland range site; pasture and hay group 7C)

Krum Series

The Krum series consists of deep, calcareous, clayey soils. Krum soils are gently sloping to sloping and occupy narrow valleys at the base of sloping hillsides.

In a representative profile, the surface layer is dark-gray, calcareous silty clay about 28 inches thick. The next layer is yellowish-brown, calcareous silty clay that extends to a depth of 60 inches.

Krum soils are well drained. Runoff is slow to rapid, and permeability is moderately slow. The available water capacity is high.

These soils are suited to crops, pasture, hay, and range.

Representative profile of Krum silty clay, 1 to 3 percent slopes, 0.2 mile north of Pipe Creek on county road, then 0.5 mile north on private road, then 100 feet east and 50 feet north in a cultivated field.

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak, fine, granular structure; very hard, very firm; few roots; common very fine particles of calcium carbonate; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—7 to 18 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate, fine, subangular blocky structure; very hard, very firm; few roots; estimated 5 percent small particles of limestone, a few as much as 1/4 inch in diameter; calcareous; moderately alkaline; clear, wavy boundary.

A12—18 to 28 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate, fine, subangular blocky structure; very hard, very firm; estimated 5 percent small particles of limestone, a few as much as 1/4 inch in diameter; shiny faces on peds; cracks as much as 1/4 inch in diameter and filled with darker colored clay from Ap and A11 horizons; calcareous; moderately alkaline; clear, wavy boundary.

B2—28 to 60 inches, yellowish-brown (10YR 5/4) silty clay; moderate, fine, subangular blocky structure; very hard, very firm; estimated 1 percent soft masses of calcium carbonate and 3 percent small fragments of limestone; a few shell fragments and ferromanganese concretions, as much as 1/8 inch in diameter, below a depth of 40 inches; weak cracks; calcareous; moderately alkaline.

The solum ranges from about 40 to more than 60 inches in thickness and has calcium carbonate values that range from 37 to 41 percent. When dry, the soil has cracks that are 0.4 to 1 inch wide and that extend to a depth of more than 20 inches.

The A horizon is dark grayish brown, very dark grayish brown, dark gray, very dark gray, or dark brown. It ranges from 20 to 35 inches in thickness. The B horizon is brown, grayish brown, yellowish brown, or reddish brown. It ranges from 18 to 30 inches in thickness.

Krum silty clay, 1 to 3 percent slopes (KM).—This soil is on uplands in the narrow valleys drained by the rivers and their tributaries. It is gently sloping and has convex slopes that average about 2 percent. Mapped areas are oblong in shape and range from 25 to 150 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are narrow bands of Krum silty clay, 3 to 5 percent slopes, and narrow strips of Denton silty clay, Nuvalde silty clay, Doss clay, or Brackett clay loam. These included areas range from 1 to 5 acres in size and make up less than 10 percent of most areas mapped as this Krum soil.

This soil is used mainly for cultivation, but a few small areas are in pasture, hay, or range. Crops are mainly small grain, grain sorghum, and crops for grazing or hay. Krum soils are easily tilled and have a high available water capacity. Water erosion is a moderate hazard. Terraces, contour farming, cover crops, and crop residues are needed to control erosion, improve or maintain soil tilth, and improve crop yields. Crops respond to applications of fertilizer if moisture is adequate. (Capability unit IIe-1; Deep Upland range site; pasture and hay group 7C)

Krum silty clay, 3 to 5 percent slopes (KN).—This mapping unit is on uplands in narrow valleys drained by rivers and their tributaries. Slopes are convex and the

dominant slope is about 3.5 percent. Mapped areas are oblong in shape, range from 25 to 200 acres in size, and parallel the base of hillsides.

Typically, the surface layer is dark-brown silty clay 35 inches thick. The next layer is brown silty clay 18 inches thick. The next layer is yellowish-brown clay to a depth of 60 inches.

Included with this soil in mapping are narrow bands of Krum silty clay, 1 to 3 percent slopes, and bands of Doss clay or Brackett clay loam. These included areas range from 1 to 5 acres in size and make up less than 10 percent of the average area mapped as this Krum soil.

This soil is used mainly for crops. The crops are mainly small grain and hay, but a few small areas are used for pasture, hay, or range. The hazard of water erosion is high. Terracing and contour farming or drilled crops help control water erosion. Management of crop residue on the soil surface helps control erosion and maintain or improve soil condition. (Capability unit IIIe-2; Deep Upland range site; pasture and hay group 7C)

Krum-Denton association, gently undulating (KRX).—This association is in narrow valleys in the draws or canyons at the head of streams that drain into the rivers. Typically this unit begins in the narrow, V-shaped drainageways. Mapped areas are long and narrow in shape and range from 50 to 250 acres in size. Slopes are convex and range from 1 to 5 percent.

Krum soils make up about 50 to 60 percent of each mapped area and occur in all mapped areas. Krum soils in this association have a surface layer of dark-brown, calcareous, silty clay about 22 inches thick. The next layer is brown, calcareous silty clay about 26 inches thick. The next layer is grayish-brown, calcareous silty clay to a depth of 60 inches.

Denton soils make up 10 to 40 percent of each mapped area and occur in 60 percent of the mapped areas. Denton soils in this association have a surface layer of dark-brown, calcareous, silty clay about 16 inches thick. The next layer is brown, calcareous silty clay about 19 inches thick. The next layer is fractured limestone.

Included in mapping are narrow bands of Doss clay, Tarrant stony clay, and Brackett clay loam. Soils that have slopes of as much as 8 percent are also included. Included areas range from 1 to 10 acres in size and make up less than 20 percent of the average mapped area of this association.

The soils in this association could be mapped separately, but separating them is not justified because their use and management are similar.

The soils in this mapping unit are used mainly for range, but they are well suited to pasture. They may be used for crops. The available water capacity is high. The water intake rate is good, and soil crusting is not a concern of management, except under heavy grazing. Water erosion is a moderate hazard. Management of crop residue on the soil surface helps control water erosion and maintain soil tilth. If the soils are used to grow field crops, terracing and contour farming help to control water erosion. (Capability unit IVe-1; Deep Upland range site; pasture and hay group 7C)

Nuvalde Series

The Nuvalde series consists of deep, calcareous, clayey soils. These soils are nearly level to gently sloping and have convex slopes. They occupy old, high terraces above flood plains.

In a representative profile, the surface layer is dark-brown silty clay about 10 inches thick. The next layer is reddish-brown silty clay about 24 inches thick. The underlying material is reddish-yellow clay loam that extends to a depth of about 60 inches (fig. 9).

Nuvalde soils are well drained. Runoff is slow, and permeability is moderate. The available water capacity is high.

These soils are well suited to crops, hay, pasture, and range.

Representative profile of Nuvalde silty clay, 1 to 3 percent slopes, 7.5 miles west of Bandera Courthouse on State Highway 16, then south 435 feet to a powerline pole, then west 144 feet in a cultivated field.

Ap—0 to 10 inches, dark-brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; hard, firm; few roots; few fine particles of limestone and few fragments as much as 1/2 inch in diameter; calcareous; moderately alkaline; abrupt, smooth boundary.

B21ca—10 to 17 inches, reddish-brown (5YR 4/3) silty clay; dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky and granular structure; hard, firm; few roots; common particles and concretions of calcium carbonate; few particles of limestone and few small fragments, mainly less than 1/2 inch in diameter; calcareous; moderately alkaline; gradual, smooth boundary.

B22ca—17 to 34 inches, reddish-brown (5YR 4/4) silty clay, reddish brown (5YR 4/4) moist; moderate to strong, fine, subangular blocky and granular structure; hard, firm; common particles of calcium carbonate; estimated 1 percent concretions of calcium carbonate as much as 1/2 inch in diameter; few clay films on some coarse peds; calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—34 to 44 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; massive; hard, firm; estimated 5 percent concretions of calcium carbonate, as much as 1/2 inch in diameter, and soft masses of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C2ca—44 to 60 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; massive; hard, firm; estimated 7 percent concretions of calcium carbonate and soft masses of limestone; calcareous; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. Between depths of 10 and 40 inches, the clay content ranges from 35 to 45 percent.

The A horizon is dark grayish brown, grayish brown, dark brown, or brown. It ranges from 10 to 20 inches in thickness. In places the calcium carbonate equivalent is as much as 6 percent.

The B horizon is reddish brown, light brown, or brown. It ranges from 14 to 28 inches in thickness. Few to common clay films are on the faces of many coarse peds. The calcium carbonate equivalent ranges from 47 to 49 percent.

The Cca horizon is reddish yellow, pink, or white.

Nuvalde silty clay, 0 to 1 percent slopes (ND).—This soil is on uplands near major streams. Mapped areas are oval to rectangular in shape and range from 25 to 500 acres in size. Slopes are slightly convex and average about 0.5 percent.

Typically, the surface layer is dark grayish-brown, calcareous silty clay about 18 inches thick. The next layer is brown, calcareous silty clay about 17 inches thick. The underlying material is brown, calcareous clay loam about 5 inches thick.

Included with this soil in mapping are small areas of Denton silty clay, Krum silty clay, Frio silty clay, or Doss clay. These included areas range from 1 to 5 acres in size and make up 5 to 10 percent of the average area mapped as this Nuvalde soil.

This soil is used mainly for cultivated crops, but some areas are in pasture and range. Maintaining soil condition is the main concern of management. Water erosion is a slight hazard. Crops are small grain, grain sorghum, and hay. Conservation treatment consists mainly of rotating crops, managing crop residue on or near the surface, and using soil-building crops to improve or maintain soil tilth. (Capability unit IIc-1; Deep Upland range site; pasture and hay group 7C)

Nuvalde silty clay, 1 to 3 percent slopes (NV).—This soil is on uplands near major streams. Mapped areas are oblong to rectangular and range from 25 to 350

Figure 9.—Profile of Nuvalde silty clay. This soil contains many concretions of calcium carbonate below a depth of 40 inches.

acres in size. Slopes are convex. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Krum silty clay, Frio silty clay, and Karnes fine sandy loam. Also included are narrow strips of Nuvalde soils that have slopes of 3 to 5 percent and are moderately eroded. These included areas mainly range from 1 to 5 acres in size and make up less than 15 percent of the average area mapped as this Nuvalde soil.

This soil is used mainly for cultivated crops, but some areas are used for pasture, hay, or range. Water erosion is a moderate hazard. Crops are small grain, grain sorghum, and hay crops. Terraces and contour farming help to control water erosion. Crop residue managed on the surface helps in controlling water erosion and in maintaining or improving soil tilth. (Capability unit IIe-1; Deep Upland range site; pasture and hay group 7C)

Orif Series

The Orif series consists of deep, calcareous, loamy soils that contain more than 35 percent water-worn limestone pebbles. These soils are nearly level and undulating and have complex slopes. They are on low bottom lands.

In a representative profile, the surface layer is brown fine sandy loam about 6 inches thick. The underlying material is stratified to a depth of 80 inches. It is pale brown in the upper 26 inches. It is gravelly fine sandy loam in the upper part and pale-

brown very gravelly sandy loam in the lower part. Below this is light yellowish-brown gravelly sandy loam about 10 inches thick. The next layer is light yellowish-brown fine sandy loam about 13 inches thick. Below this, to a depth of 80 inches, is very pale brown gravelly sandy loam (fig. 10).

Orif soils are well drained. Runoff is slow, and permeability is rapid. The available water capacity is low. These soils are suited to range.

Representative profile of Orif fine sandy loam in an area of Orif-Karnes association, frequently flooded, 1.1 miles northwest of the junction of State Highway 16 and Farm Road 1336 on State Highway 16, then 60 feet west of fence on bank of Medina River.

A1—0 to 6 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; slightly hard; friable; common roots, estimated 2 percent waterworn gravel as much as 1 inch in diameter; calcareous; moderately alkaline; clear, wavy boundary.

C—6 to 26 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, brown (10YR 5/3) moist; massive; soft, very friable; few roots; estimated 35 percent small rounded limestone pebbles, a few coated with thin films of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

IIC1—26 to 32 inches, pale-brown (10YR 6/3) very gravelly sandy loam, brown (10YR 5/3) moist; massive; loose, friable; estimated 80 percent rounded waterworn limestone pebbles mainly less than 2 inches in diameter, coated with thin films of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

IIC2—32 to 36 inches, light yellowish-brown (10YR 6/4) gravelly sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable; estimated 35 percent small pebbles coated with calcium carbonate and limestone pebbles that have common specks and threads of calcium carbonate; calcareous; moderately alkaline; clear, irregular boundary.

IIC3—36 to 42 inches, light yellowish-brown (10YR 6/4) gravelly sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, *very* friable; common specks and threads of calcium carbonate and estimated 50 percent limestone pebbles coated with calcium carbonate, few as much as 3 inches in diameter; calcareous; clear, wavy boundary.

IIC4—42 to 55 inches, light yellowish-brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, friable; estimated 5 percent pebbles coated with calcium carbonate and limestone pebbles that have common lime threads; calcareous; moderately alkaline; clear, wavy boundary.

IIC5—55 to 80 inches, very pale brown (10YR 7/3) gravelly sandy loam, pale brown (10YR 6/3) moist; massive; soft, friable; estimated 40 percent waterworn limestone pebbles; calcareous; moderately alkaline.

The soil ranges from 50 to 100 inches or more in thickness.

The A horizon is grayish brown, light brownish gray, brown, or pale brown. It ranges from 6 to 18 inches in thickness. The gravel content ranges from a few to as much as 25 percent of the soil material.

The C horizon is brown, pale brown, very pale brown, light brownish gray, or light gray. It ranges from 20 to 120 inches in thickness. The content of limestone pebbles ranges from 35 to about 80 percent.

Orif-Karnes association, frequently flooded (OKX).—The Orif-Karnes association is on long, narrow, frequently flooded bottom lands parallel to and in the stream channels of rivers. These areas are flooded for a period of less than 24 hours 1 to 3 times a year in most years. The slopes are nearly level and undulating within short distances and are subject to change with each flood. They range from 0 to 5 percent.

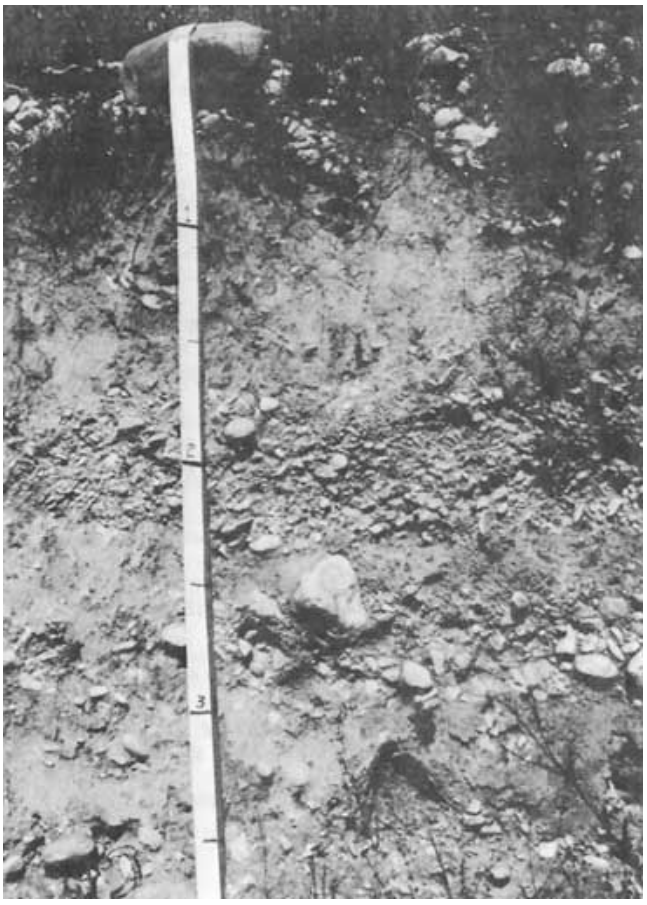


Figure 10.—Profile of Orif fine sandy loam. This soil contains gravel and is stratified throughout.

The mapping unit consists of about 45 percent Orif soil, 45 percent Karnes soil, and 10 percent other soils. Included in mapping are long, narrow strips of Frio silty clay that are 1 to 2 acres in size.

Karnes soil has a surface layer of brown, calcareous fine sandy loam about 6 inches thick. Below this is pale-brown, calcareous fine sandy loam about 6 inches thick. The next layer is light-gray, calcareous fine sandy loam about 24 inches thick. Below this is pink, calcareous fine sandy loam several feet thick.

The hazard of water erosion is high. The soils are used mainly for range, but a few small areas are in improved pasture. The area is too gravelly and the flood hazard is too severe for other uses. Conservation treatment consists of managing the native grasses so that sufficient amounts of litter are left to help control erosion. (Orif soils in capability unit VIw-1 and Karnes soils in capability unit Vw-1; not in a range site; Orif soils not in a pasture and hay group and Karnes soils in pasture and hay group 2A)

Rock Outcrop

Rock outcrop is white, indurated, massive limestone. It ranges from gently sloping to steep, depending on its occurrence in the landscape. On hilltops Rock outcrop is smooth to slightly tilted. Areas range from 2 by 5 feet to 5 by 10 feet or more in size. On hillsides Rock outcrop occurs as long, narrow contour bands that range from 1 to 3 feet in width. Rock outcrop is weakly fractured to extremely fractured. The fractures contain dark-brown clay, which gives these areas the ability to support a sparse cover of grasses, forbs, and scrub liveoak and other browse plants.

Rock outcrop is mapped only in associations with Brackett and Tarrant soils.

Spires Series

The Spires series consists of moderately deep, noncalcareous loamy soils underlain by limestone. These soils are gently undulating to sloping and have convex slopes. They are on uplands.

In a representative profile, the surface layer is reddish-brown loam about 6 inches thick. The next layer is dark-red clay about 22 inches thick. The underlying bedrock is fractured limestone at a depth of about 28 inches. Chert fragments are on the surface and in the soil (fig. 11).

Spires soils are well drained. Runoff is medium, and permeability is slow. The available water capacity is moderate.

These soils are better suited to range than to most other uses.

Representative profile of Spires loam, in an area of Spires association, gently undulating,10.8 miles north of Vanderpool on Farm Road 187, then 0.25 mile west on private road, then 0.6 mile north on private road and 60 feet east, in range.

A1—0 to 6 inches, reddish-brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; very hard, friable; many fine roots; 5 percent chert fragments, 1/2 inch to 4 inches in diameter; neutral; clear, smooth boundary.

B2t—6 to 28 inches, dark-red (10R 3/6) clay, dark red (10R 3/6) moist; moderate, medium, blocky structure; very hard, very firm; few fine roots; continuous clay films on vertical ped surfaces, few clay films on horizontal ped surfaces; 10 percent chert fragments and few chert cobbles; few earthworm burrows; mildly alkaline; abrupt, wavy boundary.

R—28 to 30 inches, indurated fractured crystalline limestone, partly weathered in upper 1 inch.

The solum ranges from 21 to 38 inches in thickness and from slightly acid to mildly alkaline. Chert fragments on the surface and in the soil range from 1/2 inch to 24 inches in diameter, but most are 1/2 inch to 6 inches in diameter. These fragments make up about 2 to 15 percent of the soil material.

The A horizon is reddish brown or dark brown and ranges from 4 to 7 inches in thickness. The B horizon is dark red or dark reddish brown. The clay content ranges from about 42 to 57 percent. The B horizon ranges from 16 to 31 inches in thickness.

Spires association, gently undulating (SPX).—This mapping unit is in broad, irregular upland areas in the northwestern part of the county at an elevation of more than 2,000 feet. The slopes are mainly 2 to 4 percent, but range from 1 to 5 percent. Mapped areas are oblong in shape and range from 85 to 1,800 acres in size.

Spires soils occur in all mapped areas and makes up about 70 percent of the average mapped area. Other soils and land types make up about 30 percent of the mapped areas.

Included with these soils in mapping are narrow strips of Tarrant soils and a soil similar to but shallower than Spires soils. Also included are narrow strips of Spires soils that have slopes of less than 1 percent or Spires soils that have slopes of as much as 8 percent. Also included in most mapped areas are areas of Rock outcrop.

The soils in this association could be mapped separately, but separating them is not justified because their use and management are similar.

This association is used for range and wildlife habitat (fig. 12). Erosion is a slight hazard, and the surface crusts when the vegetation is grazed too short. Conservation treatment consists of managing the grazing so that enough of the vegetation that grew in the current year remains for soil protection. (Capability unit IVe-2; Redland range site; pasture and hay group 7C)

Figure 11.—Profile of Spires loam that is shallow to fragments of limestone and chert.

Tarrant Series

The Tarrant series consists of very shallow to shallow, calcareous clayey soils underlain by limestone. These soils are undulating to steep and are on low hills and plateaus of the uplands.

In a representative profile, the surface layer is very dark grayish-brown, calcareous very cobbly clay, about 7 inches thick, that contains about 70 percent coarse limestone fragments 1 to 8 inches in diameter. The underlying material is fractured indurated limestone at a depth of about 7 inches.

Tarrant soils are well drained. Runoff is rapid, and permeability is moderately slow. The available water capacity is low.

These soils are suited to range and wildlife habitat.

Representative profile of Tarrant stony clay, in an area of Tarrant-Rock outcrop association, undulating, 0.1 mile east of the junction of Farm Road 1283 and State Highway 16, then 1.5 miles north on county road, then 1.25 miles northwest on private road and 20 feet east, in range.

A1—0 to 7 inches, very dark grayish-brown (10YR 3/2) very cobbly clay, very dark brown (10YR 2/2) moist; weak, fine, granular and subangular blocky structure; hard, firm; common fine roots; estimated 70 percent is coarse limestone fragments 1 inch to 8 inches in diameter; calcareous; moderately alkaline; abrupt, wavy boundary.

Figure 12.—Areas of Spires association, gently undulating, where scattered, large post oaks grow on a savannah.

R—7 to 10 inches, fractured indurated limestone

The solum ranges from 5 to 14 inches in thickness and contains from 35 to 80 percent coarse limestone fragments that range from 1 inch to 14 inches in diameter. The A horizon is dark grayish-brown, very dark grayish-brown, or dark-brown cobbly to very cobbly clay or silty clay.

Tarrant-Brackett association, steep (TBX).—This mapping unit is on steep hillsides. Slopes range mainly from about 20 to 45 percent. The steeper areas are on the upper part of the hillsides. Tarrant stony clay occupies the upper 25 to 75 percent of the mapped areas and Brackett clay loam occupies the lower 25 to 75 percent. The proportion of Tarrant soil is larger in the western part of the county, but that of Brackett soil is larger in the eastern part of the county. Mapped areas are crescent-shaped and range from 100 to 2,000 acres in size.

Typically, the Tarrant soil in this mapping unit has a surface layer of very dark grayish-brown, calcareous very cobbly clay, about 6 inches thick, that contains an estimated 80 percent of limestone fragments. These fragments range from 3 to 8 inches in diameter. The next layer is fractured indurated bedrock.

Tarrant soil is low in available water capacity, but plants anchor their roots in bedrock fractures. Because light rains are effective in providing moisture, these steep, stony areas have the ability to support both grass and trees.

Typically, the Brackett soil has a surface layer of light brownish-gray, calcareous clay loam about 6 inches thick. The next layer is grayish-brown, calcareous, clay loam about 6 inches thick. Below this is very pale brown calcareous clay loam about 4 inches thick. The soil is underlain by interbedded strata of chalky limestone, indurated limestone, and marl.

Brackett soil has low available water capacity, and contains large amounts of lime.

Included in mapping are small areas of Doss clay, Denton silty clay, or Krum silty

clay. These areas range from 1 to 5 acres in size. Some areas of Tarrant and Brackett soils that have slopes that range from 9 to 50 percent are also included.

The soils in this association could be mapped separately, but separating them is not justified because their use and management are similar.

The soils of this association are used for range and wildlife habitat. The hazard of water erosion is high. Conservation treatment consists of leaving enough cover of grasses or trees on the soil to control water erosion. (Tarrant soil in capability unit VIIs-1, Brackett soil in capability unit VIIs-2; Tarrant soil in Steep Rocky range site, Brackett soil in Steep Adobe range site; not in a pasture and hay group)

Tarrant-Doss association, undulating (TDX).—This mapping unit is undulating and is on uplands. Slopes range from 1 to 8 percent but are mainly about 4 percent. The association is about 60 percent Tarrant soils, 30 percent Doss soils, and 10 percent other soils. Mapped areas are oval to oblong in shape and range from 25 to 250 acres in size.

Typically, the Tarrant soils in this association have a surface layer of dark-brown, calcareous cobbly clay 10 inches thick. This layer is 40 percent limestone fragments 1 to 6 inches in diameter. The next layer is fractured indurated limestone. Slopes range from 1 to 8 percent.

Typically, the Doss soils in this association have a surface layer of dark-brown, calcareous silty clay 7 inches thick. The next layer is reddish-brown calcareous clay 7 inches thick. Below this is weakly cemented limestone. Slopes range from 1 to 5 percent.

Included in mapping are strips of Rock outcrop, Brackett clay loam, or Denton silty clay. They make up about 10 percent of the average mapped area. Inclusions range from 1 to 5 acres in size.

These soils could be mapped separately, but separating them is not justified because their use and management are similar.

These soils are used for range. Doss soils are suitable for cultivation, but because of the size and pattern of the areas, farming is not feasible. Water erosion is a moderate hazard. Conservation treatment consists of improving or maintaining a good cover of native grasses, forbs, and browse to control erosion and surface crusting. (Tarrant soils in capability unit VIIs-1, Doss soils in capability unit IIIe-3; Tarrant soils in Low Stony Hills range site, Doss soils in Shallow range site; not in a pasture and hay group)

Tarrant-Rock outcrop association, undulating (TRX). —This mapping unit is undulating and has slopes that range from 1 to 8 percent but that are mainly 4 to 6 percent. It is on uplands. The association is about 78 percent Tarrant soils, 18 percent Rock outcrop, and 4 percent other soils. Mapped areas range from rounded to long and narrow in shape and from 50 to 700 acres in size.

The Tarrant soil has the profile described as representative of the series. The Rock outcrop is exposed fractured limestone bedrock.

Tarrant soil is low in available water capacity, but plant roots extend into fractures and crevices in the fractured limestone.

Included in mapping are small bands or pockets of Doss clay, Denton silty clay, or Spires loam that range from 1 to 5 acres in size. Some Tarrant soils that have slopes of 8 to 12 percent are also included.

The soils could be mapped separately, but separating them is not justified because their use and management are similar.

This mapping unit is used for range and wildlife habitat. Because light rains are effective in providing moisture, the Tarrant soil can support trees and moderate amounts of forage most years. Rock outcrop produces small amounts of forage in most years. Erosion is a moderate hazard. Conservation treatment consists of maintaining or improving a good cover of native grasses (fig. 13) and forbs that help control erosion and keep evaporation losses low. In some areas brush control is

needed. (Capability unit VIIs-1; Low Stony Hills range site; not in a pasture and hay group)

Tarrant-Rock outcrop association, steep (TSX).—This mapping unit is on steep hillsides at the head of canyons. The slopes range from about 20 to 40 percent. The association is about 70 percent Tarrant soils and 30 percent Rock outcrop. Mapped areas are crescent to oblong in shape and range from 50 to 2,000 acres in size.

Typically, the Tarrant soil in this association has a surface layer of dark-brown very cobbly clay, 6 inches thick, that contains an estimated 65 percent limestone fragments 1 to 14 inches in diameter.

Included in mapping are narrow bands of Brackett soils at the base of hills and narrow bands of Krum soils along drainageways. Inclusions range from 1 to 5 acres in size. Also included are areas that have slopes of 9 to 50 percent.

The soils could be mapped separately, but separating them is not justified, because their use and management are similar.

These soils are used for range and wildlife habitat. They support a stand of scrubby trees and grasses. The trees anchor their roots in the cracks and crevices of the fractured limestone that are filled with soil. Small rains are effective in providing moisture. The hazard of water erosion is high. Conservation treatment consists of leaving enough cover of vegetation on the soil to help control water erosion. Brush control or selective thinning may be practical in a few areas. (Capability unit VIIs-1; Steep Rocky range site; not in a pasture and hay group)

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and gives the predicted average acre yields for the principal crops grown in Bandera County. It also contains information about management of the soils for pasture and hay and for range, and about use of the soils for wildlife habitat and for engineering purposes.

Capability Grouping

Some readers, particularly those who farm or ranch on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. They can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops or forage. The subclass indicates major kinds of limitations

Figure 13.—An area of Tarrant-Rock outcrop association, undulating, that has been seeded to King Range bluestem.

within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter—e, w, s, or c—to the class numeral, for example, IIe. The letter "e" shows that the main limitation is risk of erosion, unless close-growing plant cover is maintained; "w" means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); "s" shows that the soil is limited mainly because it is shallow, droughty, or stony; and "c" indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses w, s, and c, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, require about the same management, and have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

The classes and units in the capability system in Bandera County are described in the list that follows. The unit designation for each soil is given in the "Guide to Mapping Units."

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Unit IIe-1.—Deep to moderately deep, gently sloping, calcareous soils that have a fine-textured surface layer and moderate to slow permeability.

Unit IIw-1.—Deep, nearly level, calcareous soils that have a fine-textured surface layer and very slow permeability.

Unit IIc-1.—Deep, nearly level, calcareous soils that have a fine-textured surface layer and moderate permeability.

Unit IIc-2.—Deep, nearly level, calcareous soils that have a fine-textured surface layer and moderately slow permeability.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Unit IIIe-1.—Moderately deep, nearly level to gently sloping, noncaleareous soils that have a fine-textured surface layer and very slow permeability.

Unit IIIe-2.—Moderately deep to deep, gently sloping, calcareous soils that have a fine-textured surface layer and slow to moderately slow permeability.

Unit IIIe-3.—Shallow, gently sloping, calcareous soils that have a fine-textured surface layer and moderately slow permeability.

Unit IIIs-1.—Deep, gently sloping, calcareous soils that have a moderately coarse textured surface layer and moderately rapid permeability.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Unit IVe-1.—Moderately deep to deep, gently undulating to undulating, calcareous soils that have a fine-textured surface layer and slow to moderately slow permeability.

Unit IVe-2.—Moderately deep, gently undulating, noncalcareous soils that have a medium-textured surface layer and slow permeability.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, or wildlife habitat.

Unit Vw-1.—Deep, nearly level and undulating, calcareous soils that have a moderately coarse textured surface layer and moderately rapid permeability.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, or wildlife habitat.

Unit VIw-1.—Deep, nearly level and undulating, calcareous soils that have a moderately coarse textured surface layer and rapid permeability.

Unit VIs-1.—Shallow, undulating, calcareous soils that have a moderately fine textured surface layer and moderately slow permeability.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, or wildlife habitat.

Unit VIIs-1.—Very shallow to shallow, undulating to steep, calcareous soils that have a cobbly to very cobbly fine-textured surface layer and moderately slow permeability.

Unit VIIs-2.—Shallow, hilly to steep, calcareous soils that have a moderately fine-textured surface layer and moderately slow permeability.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Predicted Yields

The predicted average acre yields of the principal crops grown in Bandera County are shown in table 2. Estimates are based on information obtained from experiment stations, farmers, and those who work with farmers. Other crops are grown in the county, but they are not listed because the acreage is small and reliable yield data are not available. Soils not shown in table 2 are not cultivated or do not have a large enough acreage for accurate estimates.

The table shows the yields that can be expected under improved management. The following practices are used under improved management:

1. All cultivation is done when moisture conditions are favorable.
2. Proved plant varieties are used and planted at the right time and at the right depth.
3. Weeds and insects are properly controlled.

4. Large amounts of organic material are left on the soil.
5. Diversions and terraces, if needed, are built and properly maintained.
6. Fertilizer is applied at the right time and in the amounts indicated by soil tests.
7. The land is not grazed when the soil is wet, and grazing crops are not overused.

Pasture and Hay Groups

The soils in Bandera County have been placed in pasture and hay groups according to their suitability for the growth of forage. The soils in each group are enough alike to be suited to the same grasses, to require similar management, and to produce similar yields. These groups are a convenient method of recommending management for all soils in that group. The pasture and hay group for each soil in Bandera County is identified by a number and a capital letter at the end of each mapping unit description and in the "Guide to Mapping Units" at the back of this survey.

Pasture and hay groups are generally assigned locally but are a part of a statewide system. All of the groups in the system are not represented by soils in Bandera County, therefore the numbers and letters are not consecutive. Each pasture and hay group in Bandera County is described in the paragraphs that follow.

Pasture and hay group 1C

This group consists of nearly level soils that are on bottom lands and have a clayey surface layer. These soils are moderately slowly permeable and have a high available water capacity. If they are not protected, some areas may be flooded. Soils in this group need fertilizer to maintain adequate production of forage. The production potential is high for such species as improved bermudagrass, johnsongrass, and kleingrass.

Pasture and hay group 2A

This group consists of gently sloping soils that are on bottom lands and have a loamy surface layer. These soils are moderately rapidly permeable and have a moderate available water capacity. If they are not protected, they may be flooded. Soils in this group need fertilizer to maintain adequate production of forage. The production potential is high for such species as improved bermudagrass, johnsongrass, indiangrass, and kleingrass.

Pasture and hay group 7A

This group consists of clayey, nearly level to gently sloping soils on uplands. These soils crack and take water rapidly when dry, but they expand and are very slowly permeable when wet. They have moderate to high available water capacity. The soils are seasonally wet or seasonally droughty. They become puddled if grazed when wet. Seedbed preparation is difficult because of the clayey texture. Soils in this group need fertilizer to maintain adequate production of forage. The production potential is high for such species as improved bermudagrass and kleingrass. Among the medium-producing grasses are King Ranch bluestem and Kleberg bluestem.

Pasture and hay group 7C

This group consists of nearly level to sloping soils that are on uplands and have a loamy to clayey surface layer. These soils are moderately rapidly to slowly permeable and have a moderate to high available water capacity. Soils in this group need fertilizer to maintain adequate production of forage. The production potential is high for such species as improved bermudagrass, kleingrass, indiangrass, and weeping lovegrass. The production potential is medium for such species as King Ranch bluestem and Kleberg bluestem.

Pasture and hay group 13A

This group consists of gently sloping soils that are shallow and have a clay surface layer. These soils are slowly permeable and have a low available water capacity. Soils in this group need fertilizer to maintain adequate production of forage. Fertilizer should be applied according to soil depth. The production potential is low to medium for such species as improved bermudagrass, King Ranch bluestem, and Kleberg bluestem.

Use of the Soils for Range

R. J. Pederson, range conservationst, Soil Conservation Service

This section discusses the use of native range in Bandera County. It also explains range condition classes and describes range sites in the county. About 443,300 acres of agricultural land is used as range. Range is primarily native vegetation, which supports domestic livestock and deer and other wildlife. Most of the soils produce a mixture of grasses, forbs, and shrubs or trees. The variety of forage and topography makes the range suitable for goats, sheep, and cattle and for deer, turkey, and other wildlife.

Growth of native vegetation is variable because of variations in annual and seasonal rainfall. Dry years often occur, resulting in greatly decreased forage yield and in deterioration of the plant cover. Keeping livestock numbers in balance with the variable forage yield is an important seasonal and yearly job for the stockman. Spring and early summer growth normally accounts for 60 to 70 percent of the total amount of forage produced each year. Another growth occurs in August, September, and October following fall rains. The more fertile deep soils produce some grasses and forbs that produce some growth late in winter and early in spring in years when winter rainfall is favorable.

The success of the stockman depends largely upon using the soil to produce good forage plants that are abundant, vigorous, and productive. This is done primarily by managing the time and intensity of grazing and by applying needed treatment for each soil to permit reestablishment and growth of the natural plant community.

Range has value as a watershed for the supply of clean water for wells, springs, and creeks from runoff and ground water. Range can also be used as wildlife habitat and for recreation. Range is the major renewable natural resource in the county.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They are generally the tallest and most productive perennial grasses and forbs and are the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with

increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. Important changes in the kind of cover on a range site must be recognized. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods under the supervision of a careful manager may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

In the following pages, the range sites of Bandera County are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The range site for each soil in the county can be determined by referring to the “Guide to Mapping Units” at the back of this survey.

Adobe range site

Soils of this site are shallow, gently sloping to sloping, loamy, and calcareous; they are underlain by chalky limestone. The soils erode and surface crusts form when the grass cover is short. Although the available water capacity is low, plants respond well to light rains. The forage produced on this site is generally low in quality and deficient in phosphorus most of the year.

The climax plant community is primarily grasses, along with Texas oak, live oak, and other shrubs. In this community, little bluestem produces about 65 percent of the total annual yield; indiangrass, 5 percent; sideoats grama, 5 percent; seep muhly, 5 percent; dropseeds, 5 percent; Texas oak, live oak, shin oak, and skunkbush, 10 percent; and other grasses and forbs 5 percent. If the range is in excellent condition, the total annual yield per acre varies from 3,500 pounds of air-dry herbage in years of good growing conditions to 1,500 pounds in dry years.

If the site is continuously overused by cattle, grasses thin out and woody shrubs thicken or invade. If the site is overused by sheep, goats, and deer, stands of palatable forbs, shrubs, and grasses become thinner. Juniper (cedar) invades when the preferred range plants are overgrazed. The Adobe range site responds to good grazing management (fig. 14). Range seeding is effective after the brush has been controlled by bulldozing where needed.

Bottomland range site

Soils of this site are deep, nearly level, calcareous, and clayey; they are near stream channels (fig. 15). The available water capacity is high.

The climax plant community varies because of differences in the amount of extra water the soils receive. Tall grasses and trees grow near the streams, and a mixture of grasses, forbs, and some trees grow in the higher areas. Cypress trees grow along the edges of the more permanent water courses.

In the climax plant community, indiangrass produces about 15 percent of the total annual yield; little bluestem, 15 percent; switchgrass, 10 percent; big bluestem, 5 percent; Canada and Virginia wildryes, 10 percent; meadow dropseed, 5 percent; Texas wintergrass, 5 percent; vine-mesquite, 5 percent; oak, cypress, pecan, and shrubs, 15 percent; and forbs and other plants, 15 percent. If the range is in excellent condition, the total annual yield per acre ranges from 6,000 pounds of air-dry herbage in years of good growing conditions to 3,500 pounds in dry years.

If grazing is continuous and heavy, tall grasses decrease and are replaced by buffalograss, Texas winter grass, and many kinds of annual grasses and weeds.

This site can be reseeded successfully after the trees are controlled by bulldozing and a seedbed is prepared.

Deep upland range site

Soils of this site are moderately deep to deep, nearly level to sloping, and loamy to clayey. The available water capacity is moderate to high.

The climax plant community is prairie that has motts of live oak. In this community, little bluestem (fig. 16) produces about 35 percent of the total annual yield; indiangrass, 20 percent; sideoats grama, 10 percent; Canada wildrye, 5 percent; Texas wintergrass, 5 percent; meadow dropseed, 10 percent; vine-mesquite, 5 percent; live oak, 3 percent; and forbs and other plants, 7 percent.

If the range is in excellent condition, the total annual yield per acre ranges from 4,500 pounds of air-dry herbage in years of good growing conditions to 2,500 pounds in dry years.

If the site is grazed closely and continuously, stands of indiangrass, bluestem, and wildrye become thinner. Texas wintergrass and buffalograss increase, and plants such as prairie coneflower, mesquite, and three-awn invade. A seedbed can be prepared on this site, and range seeding is successful.

Low stony hill range site

Soils of this site are very shallow to shallow, undulating very cobbly clays. These soils have fragments of rock throughout the profile (fig. 17). Bedrock crops out, but there are pockets of deeper soil between the rocks. The available water capacity is low, but moisture from rains concentrates between rocks. Large rains of 3 or more inches result in runoff or percolation into the rock crevices. Runoff is excessive in places where the range has been overused and cover is depleted. Stones favorably affect moisture content in the soils.

The climax plant community is a mixture of grasses and forbs, along with shin oak, live oak, sumac, and other browse plants. In this community, little bluestem produces about 30 percent of the total annual yield; indiangrass, 5 percent; sideoats grama, 20 percent; green sprangletop, 5 percent; plains lovegrass, 5 percent; Canada wildrye and sedge, 5 percent; hairy and tall dropseeds, 5 percent; fall witchgrass, 5 percent; live oak and shin oak, 10 percent; sumac, elbowbush, kidneywood, honeysuckle, hackberry, and wild plum, 5 percent; and perennial forbs and annuals, 5 percent. If the range is in excellent condition, the total annual yield per acre varies from 1,700 pounds of air-dry herbage in years of good growing conditions to 1,200 pounds in dry years.

Figure 14.—An area of Adobe range site, after clearing and range deferment, where the native grasses, bluestems, dropseeds, and gramas have increased in vigor and produced a seed crop. The soils are in the Brackett series.

If the site is continuously overused by sheep, goats, and deer, stands of browse plants and perennial forbs, such as gaura and Engelmanndaisy, become thinner. Heavy grazing by cattle causes stands of bluestem to become thinner (fig. 18).

Oak can be selectively controlled by mechanical uprooting and application of chemicals. The mixture of vegetation and the topography make this a preferred site for deer.

Redland range site

Soils of this site are moderately deep, nearly level to gently sloping, and loamy to clayey. The available water capacity is moderate. Small rains are not effective, and some plants die out in drought years. The quality of forage is good.

The climax plant community is a mixture of grasses and scattered post oak. In this community, little bluestem produces about 30 percent of the total annual yield; indiangrass, 20 percent; sideoats grama, 10 percent; Canada wildrye, 5 percent; Texas wintergrass, 5 percent; meadow dropseed, 10 percent; buffalograss and curly mesquite, 5 percent; plains lovegrass, 5 percent; post oak, blackjack oak, and other woody plants (fig. 19), 5 percent; and perennial forbs and other plants, 5 percent. If the range is in excellent condition, the total annual yield per acre varies from 4,500 pounds of air-dry herbage in years of good growing conditions to 2,000 pounds in dry years.

If the site is continually overused, stands of buffalograss, curly mesquite, and Texas wintergrass become thicker, stands of bluestem and indiangrass become thinner, and annual weeds invade.

Figure 15.—Area of Bottomland range site where native pecans are growing. The soil is Frio silty clay.

Shallow range site

Soils of this site are shallow, gently sloping, and clayey; they are on uplands (fig. 20). The available water capacity is low. Excess runoff occurs where the cover is reduced.

The climax plant community is a mixture of short and medium grasses and a few forbs and small groves of live oak trees. In this community, little bluestem produces about 40 percent of the total annual yield; indiangrass, 5 percent; sideoats grama, 15 percent; plains lovegrass, 5 percent; Texas wintergrass, 5 percent; Canada wildrye, 5 percent; meadow dropseed, 5 percent; pinhole bluestem, 5 percent; fall witchgrass, 5 percent; live oak, 5 percent; and perennial forbs and other plants, 5 percent.

If the range is in excellent condition, the total annual yield per acre ranges from 4,000 pounds of air-dry herbage in years of good growing conditions to 2,400 pounds in dry years.

If the site is continuously overused, stands of bluestem and indiangrass become thinner and annuals, three-awn, hairy tridens, persimmon, agrito, and juniper invade. Machinery can be used on this site. Range seeding is successful on this site.

Steep adobe range site

Soils of this site are shallow, hilly to steep, loamy, and calcareous. The available water capacity is low. The forage produced is generally low in quality and deficient in phosphorus most of the year. Where the plant cover is reduced, the soil erodes and contributes infertile overwash to the more productive sites below. Some areas are severely eroded. This site differs from the Adobe site in that it has less topsoil and the hazard of erosion is greater.

The climax plant community has more woody plants than the Adobe site and provides cover and food for deer. In this community, little bluestem produces about 50

Figure 16.—An area of Deep Upland range site that is used only for wildlife habitat. It has an excellent stand of little bluestem and only a small amount of pricklypear and other undesirable vegetation. The soil is Krum silty clay.

percent of the total annual yield; indiangrass, 5 percent; tall grama, 5 percent; meadow dropseed, 5 percent; sedge species, 5 percent; seep muhly, 5 percent; Texas oak, live oak, and shin oak, 15 percent; shrubs such as sumac, silk tassel, honeysuckle, elbow-bush, wild grape, and yucca, 5 percent; and forbs, annual plants, and other plants, 5 percent. If the range is in excellent condition, the total annual yield per acre varies from 2,500 pounds of air-dry herbage in years of favorable growing conditions to about 1,000 pounds in dry years.

Heavy grazing by sheep, goats, and deer causes stands of palatable forbs and browse plants to become thinner. Heavy grazing by cattle causes stands of bluestem and indiangrass to become thinner. Texas stillingia, seep muhly, and juniper invade as the stands of palatable plants become thinner.

Ashe juniper and excess oak are controlled primarily by hand cutting on this site. Distribution of grazing by cattle becomes a concern where this site is associated with other more accessible and preferred sites in a pasture.

Steep rocky range site

Soils of this site are shallow to very shallow, steep, very cobbly, and clayey. The available water capacity is low. Runoff from the rocks is caught in the cracks and pockets of soil and provides for effective use of small rains for plant growth.

The climax plant community is a mixture of grasses, forbs, low shrubs, and oak trees. In this community, little bluestem produces about 25 percent of the total annual yield; indiangrass, 5 percent; sideoats grama, 15 percent; green sprangletop, 5 percent;

Figure 17.—An area of Low Stony Hill range site where rocks and stones cover 35 percent of the surface. The soils are Tarrant-Rock outcrop association, undulating.

Canada wildrye, 5 percent; sedge, 5 percent; fall witchgrass, 5 percent; Wright's three-awn, 5 percent; live oak, shin oak, and Texas oak, 15 percent; other woody plants such as elbowbush, evergreen sumac, hackberry, silk tassel, and kidneywood, 5 percent; and perennial and annual forbs and other plants, 10 percent. If the range is in excellent condition, the total annual yield per acre varies from 1,500 pounds of air-dry herbage in years of favorable growing conditions to 1,000 pounds in dry years.

Heavy grazing by sheep, goats, and deer causes the stands of low-growing shrubs and perennial forbs to become thinner. Juniper, Texas persimmon, three-awn, and annual plants invade as overuse continues. Hand cutting eliminates woody plants. Seeding is not needed.

Use of the Soils for Wildlife

By Lynn Post and James Henson, biologists, Soil Conservation Service

The two categories of wildlife in Bandera County are native and exotic. The principal kinds of native game are whitetail deer, turkey, javelina, Russian boar, fox squirrel, cottontail rabbit, jack rabbit, bobwhite quail, and doves. Also present are furbearers, such as raccoon, fox, ringtail cat, skunk, and oppossum, and numerous species of nongame birds. Predators that frequent the county are coyote and bobcat.

Exotic or introduced big-game animals in the county are axis deer, blackbuck antelope, aoudad sheep, mouflon-barbados sheep, sika deer, fallow deer, and red deer. Most of these animals are confined by high fences, but free-ranging herds of axis deer are developing in some parts of the county.

Figure 18.—Area of Low Stony Hill range site. On right is pasture that has not been grazed for 6 months. On left is pasture that has been heavily grazed by sheep and goats for a short period. The soils are Tarrant-Rock outcrop association, undulating.

Most ponds and lakes are stocked with channel catfish, black bass, and green or red ear sunfish. Fishing is fair to good on the Medina and Sabinal Rivers, and Medina Lake offers fishing and other water-based recreation activities. Ducks and geese use the lakes and streams during migration.

Fish and wildlife resources are of great economic importance to landusers in the county.

Successful management of wildlife on any tract of land requires, among other things, that food, cover, and water be available in a suitable combination. Lack of any one of these necessities, unfavorable balance among them, or poor distribution of them may be a severe limitation and may prevent the use of the soil by desirable wildlife. Information about the soils helps in creating, improving, or maintaining suitable food, cover, and water.

Most wildlife habitats are managed by planting suitable vegetation (fig. 21), by manipulating existing vegetation, or the combination of these measures so that natural establishment, increased numbers, or improvement of desired plants is brought about. The effect of soil on growth is known for many plants and can be inferred for other plants. In addition new water areas can be created or natural ones improved for wildlife habitats.

Soils directly influence kinds and amounts of vegetation and amounts of water available, and in this way indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of the root zone, surface texture, available water capacity to a depth of 40 inches, wetness,

Figure 19.—An area of Redland range site where young trees are replacing old ones that have died and where the number of post oaks is increasing. The soil is Anhalt clay, 0 to 2 percent slopes.

surface stoniness or rockiness, hazard of flooding, slope, and permeability of the soil to air and water.

Soil interpretations for wildlife habitat serve a variety of purposes. They are an aid in selecting the more suitable sites for various kinds of management. They indicate the intensity of management needed to achieve satisfactory results. They also serve as a means of showing why it may not be generally feasible to manage a particular area for a given kind of wildlife.

These interpretations also may serve in broad-scale planning of wildlife management areas, parks, and nature areas, or for acquiring wildlife lands.

In table 3, the soils of Bandera County are rated for producing six elements of wildlife habitat and three kinds of wildlife.

The soil areas shown on the soil survey maps are rated by the type of soil and not how they may be influenced by adjoining areas. Some influences on habitat, such as elevation and aspect, must be appraised onsite.

The suitability ratings in table 3 indicate the relative suitability for various elements. A rating of 1 means that the soil is well suited to the element of wildlife habitat and that habitats generally are easily created, improved, and maintained. Few or no limitations affect management in this category, and satisfactory results are expected when the soil is used for the specified purpose.

A rating of 2 means that the soil is suited to the element of wildlife habitat and that habitats can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention may be required for satisfactory results.

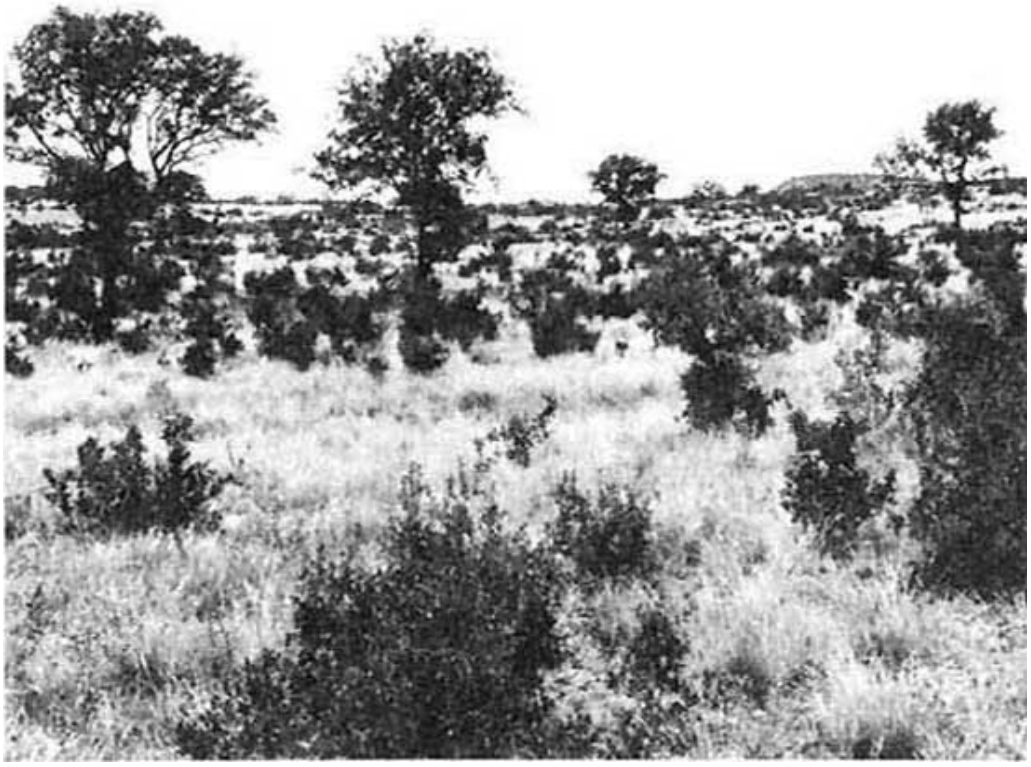


Figure 20.—An area of Shallow range site that has been cleared of oaks and ceder but has had no follow-up conservation program. The invading or undesirable woody plant is Texas persimmon. The soils are Tarrant-Doss association, undulating.

A rating of 3 means that the soil is poorly suited to the element of wildlife habitat and that limitations for the designated use are rather severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of 4 means that the soil is unsuited to the element of wildlife habitat and that unsatisfactory results are to be expected because the limitations are very severe. It is either impossible or impractical to create, improve, or maintain habitats on soils in this category.

Following are explanations of the columns in table 3.

Elements of wildlife habitat.—Each soil is rated in table 3 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitats. The ratings take into account primarily the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and population. For this reason, selection of a site for development as a wildlife habitat requires onsite inspection.

Grain and seed crops are annual grain-producing plants among which are corn, sorghum, millet, and soybeans.

Grasses and legumes are established by planting. They provide food and cover for wildlife. Among the grasses are ryegrass and panicgrass, and among the legumes are annual lespedeza, shrub lespedeza, and other clovers.

Wild herbaceous upland plants are native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Perennial lespedeza, wild bean, pokeweed, and cheatgrass are typical examples. On range, typical plants are bluestem, grama, perennial forbs, and legumes.

Hardwood trees and shrubs are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants

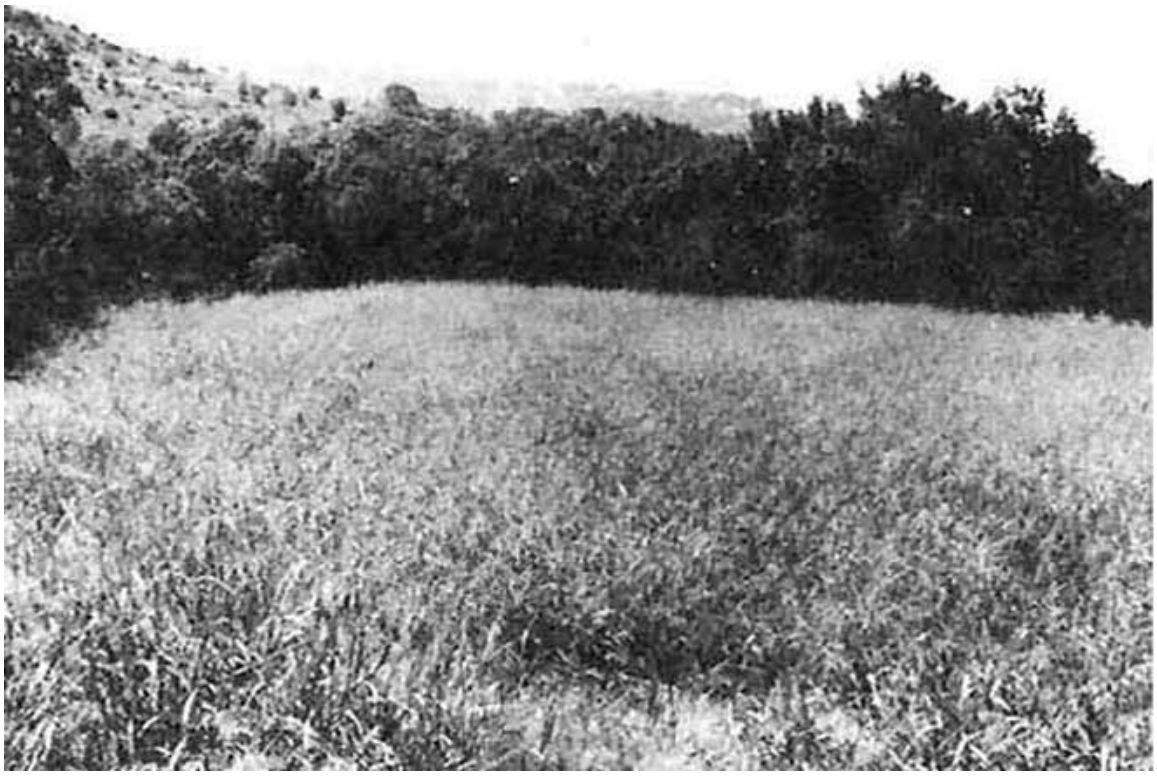


Figure 21.—An area of Krum silty clay that was cleared and planted to Hegari sorghum and sorghum almum for use by wildlife in summer. Small areas that have been cleared and seeded to summer or winter crops provide food and cover for wildlife.

grow wild in their natural environment, but they may be planted and developed through wildlife management programs. Typical species in this category are oak, viburnum, grape, honeysuckle, greenbrier, and silverberry.

Wetland food and cover plants are annual and perennial herbaceous plants that grow wild on moist and wet sites. They furnish food and cover, primarily for wetland wildlife. Typical plants are smartweed, wildmillet, spikerush and other rushes, sedges, burreed, tearthumb, and aneilema. Submerged and floating aquatics are not in this category.

Shallow water developments are impoundments or excavations for controlling water, generally not more than 5 feet deep, to create suitable habitats for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments in which submerged aquatics grow.

Kinds of wildlife.—Table *3* shows the suitability of the soils as habitat for the three kinds of wildlife in the county—openland, brushland, and wetland. These ratings are related to those made for the elements of habitat. For example, soils that are unsuited for shallow water developments are rated unsuited for wetland wildlife.

Openland wildlife are birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlark, field sparrows, cottontail rabbit, and fox are typical examples of openland wildlife.

Brushland wildlife are birds and mammals that normally live in wooded areas of hardwood trees, coniferous trees, and shrubs. Wild turkey, deer, squirrel, javelina, and raccoon are typical examples of brushland wildlife.

Wetland wildlife are birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, heron, and mink are typical examples of wetland wildlife.

Engineering Uses of the Soils

J.C. Ward, engineer, Soil Conservation Service

This section is useful to those who need information about soils used as structural material or as foundations upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of soils on which they are built, for the purpose of predicting performance on the same or similar soils in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables. Table 4 shows several estimated soil properties significant in engineering; table 5 gives interpretations for various engineering uses; and table 6 gives results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5, and it also can be used to make other useful soil maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have a special meaning to soil scientists. The Glossary defines many of the terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others, and the system adopted by the American Association of State Highway and Transportation Officials AASHTO.

In the Unified system soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter (*7, 8*). Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance (1). In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. The AASHTO classification of the soils tested is shown in table 6, and the estimated classification is given in table 4 for all soils mapped in the survey area.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 4. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties.

Following are explanations of some of the columns in table 4.

Hydrologic groups of soils give the runoff potential of rainfall. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of storms of long duration occurring after prior wetting and opportunity for swelling, and without the protective effects of vegetation.

Group A consists of soils that have a high infiltration rate even when thoroughly wetted or have a low runoff potential. These consist chiefly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission in that water readily passes through them.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils that have moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C consists of soils that have a slow infiltration when thoroughly wetted. These consist chiefly of soils that have a layer that impedes downward movement of water or soils that have moderately fine texture. These soils have a slow rate of water transmission.

Group D consists of soils that have a very slow infiltration rate when thoroughly wetted or have a high runoff potential. These consist chiefly of clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils underlain by nearly impervious material. These soils have a very slow rate of water transmission.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. “Loam,” for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, “gravelly loamy sand.” “Sand,” “silt,” “clay,” “loam,” “silty clay,” “clay loam,” “loamy sand,” “fine sandy loam,” and some of the other terms used in the U.S. Department of Agriculture textural classification are defined in the Glossary.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly

structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material as moisture content changes, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. *A high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Engineering interpretations of soils

The estimated interpretations in table 5 are based on the engineering properties of soils shown in table 4, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Bandera County. In table 5, ratings are used to summarize limitations or suitability of the soils for all listed purposes other than for grassed waterways, irrigation, and terraces and diversions. For these particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation and special designs are required.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe. Following are explanations of the columns in table 5.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and the absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result to the area from which topsoil is taken.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material from borrow areas.

Reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. The presence of stones or organic material in a soil are among factors that are unfavorable.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict

movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterways are affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Soil test data

Table 6 contains engineering test data for some of the major soil series in Bandera County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analysis were made by combined sieve and hydrometer methods.

In table *6* the shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Shrinkage ratio is the relation of the change in volume of the soil material to the water content of the soil material when the soil material is at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when oven-dry.

Mechanical analyses show the percentage, by weight, of soil particles that would pass sieves of specific sizes. Sand and coarser materials do not pass through the No. 200 sieve. Silt and clay pass through the No. 200 sieve. Silt is that material smaller than 0.05 millimeter but larger than 0.002 millimeter in diameter that passes through the No. 200 sieve. The clay fraction was determined by the hydrometer method, rather than the pipette method most soil scientists use.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic. If the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic; and the liquid limit, from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. In table *6* the data on liquid limit and plasticity index are based on tests of soil samples.

Use of the Soils in Town and Country Planning

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 7 the soils of Bandera County are rated according to limitations that affect their suitability for camp areas, picnic areas, paths and trails, playgrounds, and other uses.

In table 7 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties

are generally favorable and limitations are so minor that they can easily be overcome. *A moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. *A severe* limitation means that costly soil reclamation, special design, intensive maintenance, or a combination of these, is required.

Local roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than *6* feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, as well as the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Dwellings are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support a load and resist settlement under a load, and those that relate to ease of excavation. Soil properties that affect capacity to support a load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Light industry is affected chiefly by ease of excavation for underground utilities and corrosion potential of uncoated steel pipe. The undisturbed soil is rated for spread footing foundations for buildings less than three stories high or foundation loads not in excess of that weight.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 7 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight*

or *moderate,* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm when wet but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm when wet but not dusty when dry. If grading and leveling are required, depth to rock is important.

Corrosivity pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Concrete placed in the soil may deteriorate to varying degrees. Soil texture and acidity and the amounts of sodium, magnesium sulfate, or sodium chloride in the soil are the major factors affecting corrosion. A column for concrete was not included in table 7 because all of the soils in Bandera County are rated low.

Formation and Classification of the Soils

In the following pages, the five factors of soil formation and the processes involved in soil horizon differentiation are discussed and the system of classifying soils is explained, and the soil series are placed in higher categories.

Formation of the Soils

The five major factors of soil formation are climate, topography, time, living organisms (especially vegetation), and parent material. These factors, as they occur in Bandera County, are discussed in the following paragraphs.

Climate

The main climatic factors that influence soil formation are temperature, amount of rainfall, and seasonal distribution. Climate directly affects the soil through its influence on weathering, leaching of carbonates, translocation of clay, reduction and transfer of iron, and rate of erosion. Climate is directly responsible for the kind and amount of vegetation, therefore it reflects the amount and distribution of organic matter in the soil.

The climate of Bandera County is dry subhumid. Summers are hot and winters are cool. The major part of the annual rainfall occurs in April, May, June, September, and October.

Topography

Topography, or relief, influences soil development through its effect on drainage, erosion, plant cover, and soil temperature. The topography of Bandera County is nearly level to steep.

Soils formed in gentle sloping areas are underlain by deposits of calcium carbonate caused by the water moving through the soil and leaching the carbonates to lower layers. Water has also leached or moved the fine clay particles to a lower layer on some older soils such as those of the Spires series. Formation of soils in steeper areas has been retarded by continuous erosion.

Time

Soil characteristics are determined by the length of time the soil-forming processes have been active. A long time is generally required for a well-defined profile to develop. The soils of Bandera County range from young to old. The young soils have little profile development, are along rivers, and receive new sediment with each flood. Nuvalde soils are above flood plains and older than soils on flood plains. These soils have a developed structure and some carbonates have moved to lower horizons, forming concretions, films, and threads. Older soils, such as those of the Spires series, have well-defined horizons and have been in place a long time.

Living organisms

Plants, micro-organisms, earthworms, rodents, and other forms of life on or in the soil are active in soil-forming processes. These organisms provide organic matter, help to decompose plant residue, and affect the chemistry of the soil. The native vegetation of Bandera County is trees and grasses. The decomposition of roots and leaves furnishes food for organisms. Man also can influence the management of plants and animals.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. Parent material determines the chemical and mineralogical composition of the soil. Bandera County is underlain by indurated limestone and limestone interbedded with soft marl. The soils of Bandera County formed over limestone or in calcareous alluvial deposits.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification and then through use of soil maps we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys (2, 4), allow us to organize and apply knowledge about soils in managing farms, fields, and woods; in developing rural areas; in engineering work; and in many other

ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (6). Because this system is under continual study, readers interested in developments in the current system should study the latest literature.

The current system of classification has six categories. Beginning with the broadest, these categories are: order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Bandera County are placed in some categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol (*Ent-i-sol).

The five soil orders in Bandera County are Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols.

Alfisols have a light-colored surface layer and an accumulation of clay in the subsoil.

Entisols are recent soils that do not have natural genetic horizons or that have only the beginnings of genetic horizons.

Inceptisols are beginning soils that are most often found on young but not recent land surfaces.

Mollisols have dark-colored surface layers, high base saturation, are structured, are not hard when dry, and have a high content of organic matter.

Vertisols crack when dry and swell when wet; thus a natural churning or inversion takes place because of the high content of clay in the soil.

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of water-logging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Aquent *(Aqu,* meaning water or wet, and *ent,* from Entisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots or movement of water, or both; and thick, dark-colored surface layers. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents *(Hapl,* meaning simple horizons, *aqu* for wetness or water, and *ent,* from Entisols).

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquents (a typical Haplaquent).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reactions, soil temperature, permeability, thickness of horizons, and consistency. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae.

Additional Facts About the County

Bandera County, created in 1846 from Bexar and Uvalde Counties, was organized the same year and named for Bandera Pass. The first settlers, in 1842, were drifting shingle-makers who camped along the Medina River. They made shingles from the cypress trees growing along the river. The town of Bandera was founded in 1843. In that year the first sawmill was built. With the coming of the settlers, a small amount of land was put into cultivation. Two- to ten-acre fields were planted to corn and small grain with a fair degree of success. By 1858, the acreage of corn, barley, and wheat had increased to such an extent that a flour mill operated by waterpower was built. Raising of cattle, horses, hogs, and sheep later became the leading farm enterprise in the county.

In the early days, the range in Bandera County was covered with tall grass and was considered very poor. (Tall grass has almost disappeared.) There was little brush, and timber grew mostly in motts or groves. There was plenty of wood: Cedar, various kinds of oak, and cypress grew along the water's edge. The cypress for many years was a source of shingles and lumber.

Transportation to market was provided mostly by ox wagon or horseback. The principal market for products, particularly lumber and shingles, was San Antonio, 50 miles distant. Shingles brought $5 per thousand, and cypress lumber sold for $10 to $15 per thousand feet.

The first irrigation system in the county was on the Hondo Creek near Tarpley, and the vegetables, mainly sweet potatoes, grown under irrigation were marketed at Fort Lincoln near D'Hanis in 1846.

The first fences in this area were made of split rails or stones. One of the first stone fences was built in 1846, and parts of it are still in use. The first rail fence was built along the Medina River, just below Ranger Crossing. Barbed wire fences came into use in the county sometime in the early 1850's.

Topography and Geology

The topography of the county is that of an old, well-dissected plateau where narrow ridges or small mesas of the original plateau remain. The terrain is undulating to hilly; but some nearly level areas are along streams and steep areas are where different geologic formations come into contact.

Most of the soils formed over limestone, and approximately 75 percent of the soils are shallow to very shallow. Most of them have a clayey surface, but some that are on the plateau and near stream channels are loamy.

Geology has influenced the kinds of soils that have developed and is important in the classification and mapping of the soils. The geologic outcrops furnish guidelines as to what soils to expect in an area and in what pattern or association they may occur.

Geologic formation in Bandera County is wholly within the Mesozoic period. All the rock outcrops and the Trinity, Fredericksburg, and Washita groups (3) are rocks of lower Cretaceous age.

Most of the soils are shallow to very shallow to limestone and are in the Tarrant or Brackett series. The Tarrant soils are underlain by hard, fractured limestone of the Georgetown, Edwards, Comanche Peak, Glen Rose, and Travis Peak formations. Brackett soils developed from interbedded soft and hard layers of limestone and chalky marl, primarily of the Glen Rose formation. The hardness of the parent rock had more influence on the soil than the group to which the limestone belongs. The Glen Rose formation includes hard and soft layers, and the irregular weathering has given the slope a benched or terraced effect. Brackett soils are found on benches and Tarrant soils are over the hard limestone areas.

Spires soils are noncalcareous soils associated with and formed over the Washita Group and are limited to the plateau mainly in the northwest part of the county. Anhalt soils are noncalcareous soils associated with Edwards, Comanche Peak, and Glen Rose limestone. Denton soils are moderately alkaline soils over limestone of Comanche Peak and Glen Rose formations. Krum soils are calcareous soils developed from slope alluvium and are a composite of sediment from the Fredericksburg Group and the Trinity Group. Frio and Karnes soils are alluvial soils that occupy flood plains adjacent to streams. Frio soils are clayey calcareous soils. Karnes soils are calcareous loamy soils.

Climate

Robert S. Orton, climatogist for Texas, National Weather Service, U.S. Department of Commerce

At latitudes between 29° 35' N and 29° 55' N, Bandera County is far enough south that it escapes harsh winters. At an elevation ranging from 1,200 to 2,400 feet and at a distance of more than 150 miles from the coast, it also escapes the hot, humid summers that are characteristic of other south Texas counties. Prevailing winds are southerly throughout the year.

The climate tends to be continental in winter when polar air masses move through the area and when it is characterized by frequent variations in temperature that disrupt briefly the prevailing southerly flow of air. Weather changes occur less frequently in spring as the cold fronts become weaker with the approach of summer. Summer temperatures are more characteristic of the High Plains than of southern Texas. The combination of moderate temperatures, low wind velocity, and frequent intrusions of mild, dry, polar air masses make fall a delightful season.

Table 9 shows temperature and precipitation data. These data are based on long-term weather records kept at stations in surrounding counties. They are considered representative of Bandera County. Data are also available at Medina, which is in Bandera County, for the period 1966 to 1970, but this period is much too short for the purposes of this survey.

Temperatures are mild in winter. Winter is not marked by any prolonged periods of cold weather but rather by short periods of 36 to 72 hours. The warmer daytime temperatures occur in the afternoon. Weather changes are frequent in March, but they occur less frequently in April and May as the cold fronts become characterized by warm days and cool nights and little variation in day-to-day weather. Daytime temperatures continue warm in September, and few cold fronts reach the area. Cold fronts are more frequent after mid-October, and weather changes are more frequent.

As shown in table 9, annual precipitation averages about 29 inches. Winter precipitation is usually in the form of light rain or drizzle, and winters are comparatively dry. Rainfall increases significantly in April as thunderstorms become more frequent. May is the wettest month. In summer there is little variation in the day-to-day weather, except for an occasional afternoon or evening thundershower. Midsummer is relatively dry. Precipitation increases significantly during September as weather disturbances occasionally move eastward across the hill country from the Gulf of Mexico. November is normally dry.

The warm season, or freeze-free period, averages 235 days. The average date of the last freezing temperature of 32° F in spring is March 26, and the average date of the first in fall is November 16. Significant departures from these dates can occur locally as a result of differences in topography, exposure, soil condition, and vegetative cover.

Relative humidity is rather uniform throughout the year, but it varies considerably during the day. At noon it is estimated as averaging 57 percent in January, 55 percent in April, 47 percent in July, and 55 percent in October.

Winter mornings are most often cloudy, but partly cloudy skies and sunshine follow. In spring, the early morning cloudiness begins to break up early so that skies are usually sunny throughout late morning and the afternoon. Of the total possible sunshine, Bandera County receives in an average year about 55 percent in winter, 60 percent in spring, 75 percent in summer, and 67 percent in fall.

Mean annual lake evaporation is estimated at 64 inches. In an average year, it exceeds precipitation by 36 inches.

Literature Cited

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 v., illus.

(2) Baldwin, Mark, Kellogg, Charles E., and Thorp, James. 1938. Soil classification. U.S. Dep. Agric. Yearb, pp. 979-1001, illus.

(3) Dorton, N. H., Gardner, Julia, and Stephenson, L. W. 1937. Geologic map of Texas. U.S. Dep. Inter., Geol. Surv. Ed. G. W. Stone.

(4) Thorp, James, and Smith, Guy D. 1949. Higher categories of soil classification: order, suborder, and great soil group. Soil Sci. 67: 117-126.

(5) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(6) United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued March 1967 and September 1968]

(7) United States Department of Defense. 1968. Unified soil classification system for roads, airfields, embankments and foundations. MIL-STD-619B, 30 pp., illus.

(8) Waterways Experiment Station. 1953. The unified soil classification system. U.S. Army Corps Eng. Tech. Memo. No. 3-357, 3 v., illus.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the

difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and bring *clods* to the surface. A form of emerging tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—few, *common,* and *many; size*—*fine, medium,* and *coarse;* and contrast—faint, *distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.*

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized *are*—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or “sour,” soil is one that gives an acid reaction; an alkaline

soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 5.0 millimeters); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure *are—platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geographical). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loans, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

TABLES

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

Table 1.—Approximate acreage and proportionate extent of the soils.

Soil	Acres	Percent
Anhalt clay, 0 to 2 percent slopes	20,760	4.3
Brackett association, undulating	53,920	11.0
Brackett-Rock outcrop association, hilly	34,440	7.1
Denton silty clay, 1 to 3 percent slopes	12,910	2.6
Denton silty clay, 3 to 5 percent slopes	1,540	.3
Denton association, undulating	8,620	1.8
Doss clay, 1 to 5 percent slopes	8,760	1.8
Frio silty clay	21,080	4.3
Houston Black clay	980	.2
Karnes fine sandy loam, 1 to 3 percent slopes	1,320	.3
Krum silty clay, 1 to 3 percent slopes	4,220	.9
Krum silty clay, 3 to 5 percent slopes	3,100	.6
Krum-Denton association, gently undulating	26,660	5.5
Nuvalde silty clay, 0 to 1 percent slopes	4,920	1.0
Nuvalde silty clay, 1 to 3 percent slopes	3,430	.7
Orif-Karnes association, frequently flooded	5,800	1.2
Spires association, gently undulating	12,900	2.6
Tarrant-Brackett association, steep	81,400	16.6
Tarrant-Doss association, undulating	21,940	4.5
Tarrant-Rock outcrop association, undulating	63,330	13.0
Tarrant-Rock outcrop association, steep	96,546	19.7
Total land area	488,576	100.0
Water	2,944	
Total area	491,520	

Table 2.—Predicted average acre yields of prinicipal crops.

Soil	Oats	Oats for grazing	Oats for hay	Sudangrass for hay	Grain sorghum	Johnson-grass	Hay
	Bushels	*AUM*[1]	*Tons*	*Tons*	*Pounds*	*AUM*[1]	*Tons*
Anhalt clay, 0 to 2 percent slopes	50	6	1.50	2.00	2,500	8	3.00
Denton silty clay, 1 to 3 percent slopes	65	6	1.50	2.00	3,250	8	3.00
Denton silty clay, 3 to 5 percent slopes	50	6	1.50	2.00	3,000	8	3.00
Doss clay, 1 to 5 percent slopes	60	5	1.25	1.25	2,000	6	1.50
Frio silty clay	50	7	1.75	2.25	4,000	8	3.25
Houston Black clay	70	5	1.50	2.00	5,000	7	3.00
Karnes fine sandy loam, 1 to 3 percent slopes	40	4	1.50	1.50	2,000	6	2.50
Krum silty clay, 1 to 3 percent slopes	65	6	1.50	2.00	3,250	8	3.00
Krum silty clay, 3 to 5 percent slopes	50	6	1.50	2.00	3,000	8	3.00
Nuvalde silty clay, 0 to 1 percent slopes	55	6	1.75	2.25	4,000	8	3.25
Nuvalde silty clay, 1 to 3 percent slopes	65	6	1.50	2.00	3,250	8	3.00

[1] AUM is animal-unit-month, a term used to express the carrying capacity of pasture. It is the number of months during the grazing season that 1 acre will provide grazing for 1 animal unit (1 cow, 1 horse, 5 hogs, or 7 sheep) without damage to the pasture.

Table 3.—Suitability for elements of wildlife habitat and kinds of wildlife.

[The rating 1 means well suited, 2 means suited, 3 means poorly suited, and 4 means unsuited]

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees and shrubs	Wetland food and cover plants	Shallow water developments	Open-land	Brush-land	Wetland
Anhalt: AN	2	1	2	2	3	3	2	2	3
Brackett: BKX, BRX. For Rock outcrop part of BRX, see Rock outcrop.	3	3	3	2	4	4	3	2	4
Denton: DE, DL, DNX	2	1	2	1	4	4	2	2	4
Doss: DS	3	3	2	2	4	4	3	2	4
Frio: FR	1	1	2	1	4	4	1	1	4
Houston Black: HO	1	1	2	2	3	3	1	2	3
Karnes: KA	2	2	1	1	4	4	2	2	4
Krum: KM, KN, KRX. For Denton part of KRX, see Denton series.	2	1	2	2	4	4	2	2	4
Nuvalde: ND, NV	1	1	2	2	4	4	1	2	4
Orif: OKX. For Karnes part of OKX, see Karnes series.	3	3	2	2	4	4	3	3	4
Rock outcrop. Mapped only in associations with Brackett and Tarrant soils.	4	4	4	4	4	4	4	4	4
Spires: SPX	2	1	1	1	4	4	1	1	4
Tarrant: TBX, TDX, TRX, TSX. For Brackett part of TBX and Doss part of TDX, see those series; for Rock outcrop part of TRX and TSX, see Rock outcrop.	4	4	2	2	4	4	3	2	4

Table 4.—Estimated soil properties significant in engineering.

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. The symbol > means more than; the symbol < means less than]

Soil series and map symbol	Hydrologic group	Depth to bedrock	Depth from surface	USDA texture	Classification		Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
					Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
		Inches	*Inches*								*Inches per hour*	*Inches per inch of soil*	*pH*	
Anhalt: AN	D	20–40	0–12	Clay	CH	A-7-6	85–100	85–100	85–100	80–95	<0.06	0.15–0.18	6.1–7.8	Very high.
			12–28	Clay	CH	A-7-6	85–100	85–100	85–100	80–95	<0.06	0.15–0.18	6.1–7.8	Very high.
			28	Indurated, fractured limestone.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
*Brackett: BOX, BRX For Rock outcrop part of BOX, see Rock outcrop.	C	10–20	0–14	Clay loam, gravelly loam	CL or SC	A-6	70–100	65–100	55–95	40–85	0.20–0.63	0.10–0.15	7.9–8.4	Low.
			14–40	Clay loam marl	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Denton: DE, DL, DNX	D	20–40	0–19	Silty clay, clay	CH or CL	A-7	80–100	80–100	80–100	75–95	0.06–0.20	0.15–0.20	7.9–8.4	High.
			19–30	Silty clay, clay	CH or CL	A-7	80–100	80–100	80–100	70–95	0.06–0.20	0.12–0.17	7.9–8.4	High.
			30–38	Silty clay, loam	CL	A-6	80–100	80–100	80–100	70–95	0.20–0.63	0.10–0.15	7.9–8.4	High.
			38–42	Fractured limestone.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Doss: DS	C	11–19	0–12	Clay, clay loam	CH	A-7-6	90–100	90–100	85–100	80–95	0.20–0.63	0.15–0.20	7.9–8.4	Moderate.
			12–17	Clay loam, clay	CH or CL	A-7-6	90–100	90–100	85–100	80–95	0.20–0.63	0.15–0.20	7.9–8.4	Moderate.
			17–30	Weakly cemented limestone.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Frio: FR	B	>70	0–37	Silty clay	CL	A-7-6	95–100	95–100	75–100	70–95	0.20–0.63	0.15–0.20	7.9–8.4	Moderate.
			37–70	Clay loam	CL	A-6	95–100	95–100	75–100	70–95	0.20–0.63	0.15–0.20	7.9–8.4	Moderate.
Houston Black: HO	D	>60	0–72	Clay	CH	A-7	95–100	95–100	95–100	85–100	<0.06	0.15–0.20	7.9–8.4	Very high.
Karnes: KA	B	>60	0–69	Fine sandy loam, loamy sand.	ML or SM	A-4 or A-6	95–100	95–100	85–100	36–60	2.0–6.3	0.10–0.15	7.9–8.4	Low.
*Krum: KM, KN, KRX For Denton part of KRX, see Denton series.	C	>60	0–28	Silty clay	CH	A-7-6	95–100	95–100	95–100	85–95	0.20–0.63	0.15–0.20	7.9–8.4	High.
			28–60	Silty clay	CH	A-7-6	85–100	75–100	70–95	65–90	0.20–0.63	0.15–0.20	7.9–8.4	High.
Navable: ND, NV	C	>60	0–34	Silty clay	CL or CH	A-6, A-7-6	95–100	95–100	90–100	60–95	0.63–2.0	0.15–0.20	7.9–8.4	Moderate.
			34–60	Clay loam	CL	A-6 or A-7	70–85	65–95	60–90	50–75	0.63–2.0	0.10–0.14	7.9–8.4	Moderate.
*Orif: OKX For Karnes part, see that series.	A	>80	0–26	Fine sandy loam, gravelly fine sandy loam.	SM or SM-SC	A-2-4 or A-4	80–85	75–95	40–60	20–40	6.3–20.0	0.05–0.10	7.9–8.4	Very low.
			26–60	Very gravelly sand gravelly sandy loam.	GW, GP, or GM; SP or SM	A-1	20–85	10–75	5–50	0–20	6.3–20.0	<0.05	7.9–8.4	Very low.
Rock outcrop. Too variable to be estimated.														
Spires: SPX	D	21–38	0–6	Loam	SC or CL	A-6	85–100	85–100	70–80	45–65	0.63–2.0	0.11–0.23	6.1–7.8	Low.
			6–38	Clay	CH	A-7-5 or A-7-6	85–100	85–95	70–80	65–80	0.06–0.2	0.13–0.18	6.1–7.8	High.
			38–39	Indurated, fractured, crystalline limestone.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
*Tarrant: TEX, TDX, TFX, TSX For Bracket part of TEX and Doss part of TDX, see those series. Rock outcrop part of TFX and TSX is too variable to be estimated.	D	5–14	0–7	Very cobbly clay	MH or CH	A-7-5 or A-7-6	80–100	80–100	70–90	70–95	0.20–0.63	0.15–0.17	7.9–8.4	High.
			7–10	Fractured, indurated limestone.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)

*Too variable to be estimated.

Table 5.—Interpretations of engineering properties of the soils.

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbol	Suitability as source of—		Degree of limitations and soil features affecting farm ponds—	Degree of limitations and soil features affecting farm ponds—continued	Soil features affecting—		
	Topsoil	Road fill	Reservoir areas	Embankments	Irrigation	Terraces and diversions	Grassed waterways
Anhalt: AN	Poor: clay	Poor: very high shrink-swell potential; plastic clay; poor stability.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: very high shrink-swell potential; plastic clay; poor stability.	Very slow permeability; bedrock at a depth of 20 to 40 inches.	Nearly level; bedrock at a depth of 20 to 40 inches.	Very slow permeability; bedrock at a depth of 20 to 40 inches.
*Brackett: BOX, BRX For Rock outcrop part of BRX, see Rock outcrop.	Poor: 74 to 78 percent calcium carbonate.	Fair on slopes of 15 to 25 percent: fair traffic-supporting capacity. Poor on slopes of 25 to 45 percent.	Severe: seepage	Moderate: low to medium compressibility.	Slope; bedrock at a depth of 20 to 40 inches.	Slope; suitable only for diversions.	Slope; bedrock at a depth of 20 to 40 inches.
Denton: DE, DL, DNX	Poor: silty clay	Poor: high shrink-swell potential.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: 24 to 40 inches of material; fair stability.	Slow permeability; slope; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches.
Doss: DS	Poor: clay; 49 to 62 percent calcium carbonate.	Poor: poor traffic-supporting capacity.	Severe: seepage	Severe: 11 to 19 inches of material.	Slope; bedrock at a depth of 11 to 19 inches.	Only 11 to 19 inches of soil material.	Droughty.
Frio: FR	Poor: silty clay	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: moderately slow permeability.	Moderate: medium compressibility.	Hazard of flooding	Hazard of flooding	Hazard of flooding.
Houston Black: HO	Poor: clay	Poor: very high shrink-swell potential; plastic clay; poor stability.	Slight	Severe: very high shrink-swell potential; plastic clay; poor stability; high erodibility.	Very slow permeability	Nearly level	Very slow permeability.
Karnes: KA	Poor: 76 to 84 percent calcium carbonate.	Fair: fair traffic-supporting capacity.	Severe: moderately rapid permeability.	Moderate: low to medium compressibility; medium to high resistance to piping; moderate to high hazard of erosion.	Moderately rapid permeability.	All features favorable; not terracable because of position.	Excess lime.
*Krum: KM, KN, KRX For Denton part of KRX, see Denton series.	Poor: silty clay	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Moderate: moderately slow permeability.	Moderate: medium compressibility.	Slope	All features favorable	All features favorable.
Navarro: NO, NV	Poor: silty clay	Poor: poor traffic-supporting capacity.	Severe: seepage	Moderate: medium compressibility.	Moderate permeability; slope	All features favorable	All features favorable.
*Orif: OOC For Karnes part, see that series.	Poor if 15 to 25 percent coarse fragments. Fair if 8 to 15 percent coarse fragments. Good if less than 8 percent coarse fragments.	Good	Severe: rapid permeability	Severe: seepage	Rapid permeability	Hazard of flooding	Hazard of flooding.
Rock outcrop. No interpretations made; properties too variable.							
Spires: SPK	Poor: 4 to 7 inches of loam	Poor: high shrink-swell potential; poor traffic-supporting capacity.	Severe: bedrock at a depth of 21 to 38 inches.	Moderate: 21 to 38 inches of borrow material; stability.	Bedrock at a depth of 21 to 38 inches.	Bedrock at a depth of 21 to 38 inches.	Bedrock at a depth of 21 to 38 inches.
*Tarrant: TBX, TDX, TRX, TSX For Brackett part of TBX and Doss part of TDX, see those series. Rock outcrop part of TRX and TSX is too variable to be estimated.	Poor: very cobbly clay	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: bedrock at a depth of 5 to 14 inches.	Severe: 5 to 14 inches of material.	Bedrock at a depth of 5 to 14 inches.	Bedrock at a depth of 5 to 14 inches.	Bedrock at a depth of 5 to 14 inches.

Table 6.—Engineering test data.

[Tests made by the Texas Highway Department, Materials and Testing Division, according to standard procedures of the American Association of State Highway and Transportation Officials (AASHTO) (1)]

Soil name and location	Parent material	Report number (S)–	Depth	Shrinkage limit	Linear shrinkage	Shrinkage ratio	Mechanical analysis[1]								Liquid limit	Plasticity index	Classification	
							Percentage less than 3 inches passing sieve—					Percentage smaller than—						
							7/8 inch	5/8 inch	3/8 inch	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.005 mm	0.002 mm		AASHTO[2]	Unified[3]
			Inches														Percent		
Anhalt clay:																			
Approximately 1.9 miles east of intersection of Texas Highway 16 and Farm Road 689 on southeast side of Bandera, approximately 275 feet east of Lost Valley Downs entrance, in idle cropland. (Modal)	Limestone.	590–R	0–12	12	21.0	1.97					100	99	95	93	64	56	65	42	A–7–6	CH
		591–R	12–28	13	22.7	1.96		100	99	99	99	96	95	94	66	60	72	47	A–7–6	CH
Approximately 2.3 miles north of intersection of Texas Highway 16 and Farm Road 689 on east side of Bandera, approximately 1.3 miles north on county road to Bill Hathaway Ranch, approximately 0.75 mile west on private road to southwest corner of field, approximately 200 feet southwest, in range. (Redder than modal)	Limestone.	582–R	0–4	16	18.1	1.90		100	99	99	98	98	93	86	51	43	59	35	A–7–6	CH
		583–R	4–26	16	21.6	1.91					98	98	95	92	73	64	73	45	A–7–6	CH
Denton silty clay:																				
Approximately 2.6 miles west of intersection of Ridge Route Road and Farm Road 689, 0.9 mile north of intersection of Farm Road 689 and Texas Highway 16 on west side of Bandera, 300 feet west of southeast field boundary and 50 feet north of south boundary. (Modal)	Limestone and marl.	577–R	0–9	11	19.1	1.99			100	99	99	97	91	86	57	41	56	33	A–7–6	CH
		578–R	13–26	16	14.4	1.86				100	99	95	89	87	65	46	49	29	A–7–6	CL
Approximately 0.35 mile northeast of the intersection of Farm Road 689 and Texas Highway 16, approximately 3.3 miles north of intersection of Farm Road 689 and Texas Highway 16 on west side of Bandera, approximately 200 feet northeast of field boundary and 50 feet south of pasture fence on Charley Stein Ranch, in range. (Thinner surface layer than modal)	Limestone and marl.	584–R	0–10	14	19.6	1.88					100	98	92	77	59	38	63	33	A–7–5	CH
		585–R	10–26	17	15.1	1.91			100	99	97	94	90	83	69	43	59	26	A–7–6	CL or CH
Doss clay:																				
0.9 mile north of intersection of Farm Road 689 and Texas Highway 16 on west side of Bandera, approximately 2.6 miles west of intersection of Farm Road 689 and Ridge Route Road, 600 feet west and 75 feet north of A.J. East Ranch entrance. (Modal)	Limestone and marl.	579–R	0–9	11	19.9	1.99					100	98	93	88	57	45	57	33	A–7–6	CH
		580–R	9–14	13	18.5	1.95					100	97	92	86	57	44	57	33	A–7–6	CH
Approximately 1.9 miles east of intersection of Farm Road 689 and Texas Highway 16 on west side of Bandera, approximately 400 feet north of Lost Valley Downs entrance on Texas Highway 16, near west end of a large pit. (Redder than modal)	Limestone and marl.	592–R	0–7	13	19.8	1.98			100	99	99	99	95	91	57	49	61	39	A–7–6	CH
		593–R	7–17	13	19.4	1.97			100	99	99	96	90	88	56	46	59	35	A–7–6	CH
Norwalk silty clay:																				
Approximately 7.5 miles west of Bandera Courthouse on Texas Highway 16, 425 feet south of north field boundary and 1,141 feet west of powerline pole, in a cultivated field. (Modal)	Alluvium of the Medina River.	574–R	0–11	14	19.0	1.95					100	99	98	94	57	45	58	33	A–7–6	CH
		575–R	11–26	15	17.5	1.93					99	96	91	84	53	43	58	33	A–7–6	CH
		576–R	26–60	15	13.1	1.88					98	91	71	70	43	31	42	25	A–7–6	CL
Approximately 0.25 mile southeast of intersection of Texas Highway 16 and Farm Road 689 on southeast side of Bandera, approximately 2.5 miles north of intersection of county road and Farm Road 689, approximately 0.12 mile east of Langford Farm entrance, 150 feet east of a large live oak tree in a field. (Redder than modal)	Alluvium of the Medina River.	587–R	0–13	16	16.4	1.87			100	99	99	98	90	85	56	36	54	30	A–7–6	CH
		588–R	13–42	14	15.3	1.86				100	99	97	91	85	56	47	57	34	A–7–6	CH
		589–R	42–66	16	14.4	1.84					98	92	70	67	48	36	47	29	A–7–6	CL
Spires loam:																				
Approximately 10.8 miles north of Vanderpool on Farm Road 187, 2.25 miles west of intersection of private road and Farm Road 187, in northeast corner of Old County Road and private road, approximately 60 feet east of Old County Road on Stuart Haby Ranch. (Modal)	Hard crystalline limestone.	595–R	0–6	19	9.7	1.76		100	99	99	98	96	73	60	37	27	39	21	A–6	CL
		596–R	6–28	17	18.1	1.88		100	100	99	98	94	79	75	61	56	62	31	A–7–5	CH
Approximately 10.8 miles north of Vanderpool on Farm Road 187, 1.25 mile west-southwest to Stuart Haby Ranch headquarters, 0.3 mile southeast on pasture road, approximately 30 feet west. (Modified in lower layer)	Hard crystalline limestone.	597–R	0–8	20	6.6	1.68		100	99	99	98	96	73	50	48	17	34	17	A–6	SC
		598–R	8–26	13	22.7	1.96		100	98	96	90	75	68	67	54	45	72	45	A–7–6	CH

[1] Mechanical analysis according to the AASHTO Designation T 88-57 (1). Results by this procedure may differ somewhat from material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

[2] Based on AASHTO Designation M 145-49 (1).

[3] Based on MIL-STD-619B (7).

Table 7.—Degree and kind of limitations for town and country planning.

Soil series and map symbol	Degree of limitations and soil features affecting—										Corrosivity of uncoated steel
	Roads and streets	Dwellings	Light industry	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Camp areas	Picnic areas	Paths and trails	Playgrounds	
Anhalt: AN	Severe: high shrink-swell potential; poor traffic-supporting capacity.	Severe: very high shrink-swell potential.	Severe: very high shrink-swell potential.	Severe: very slow permeability.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: clay; very slow permeability.	Severe: clay	Severe: clay	Severe: clay; very slow permeability.	High: clay.
Brackett: BDL, BEK For Rock outcrop part of BEK, see Rock outcrop.	Moderate where slope is 8 to 15 percent; fair traffic-supporting capacity. Severe where slope is 15 to 45 percent.	Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 45 percent.	Moderate where slope is 1 to 8 percent; high corrosivity. Severe where slope is 8 to 45 percent.	Severe: moderately slow permeability; slope of 15 to 45 percent.	Moderate where slope is 1 to 7 percent: rippable limestone. Severe where slope is 7 to 45 percent.	Moderate where slope is 15 to 25 percent: clay loam. Severe where slope is 25 to 45 percent.	Moderate: moderately slow permeability.	Slight where slope is 1 to 8 percent. Moderate where slope is 8 to 15 percent. Severe where slope is 15 to 45 percent.	Moderate where slope is 15 to 25 percent: clay loam. Severe where slope is 25 to 45 percent.	Moderate where slope is 1 to 6 percent: moderately slow permeability. Severe where slope is 6 to 45 percent.	High: resistivity.
Denton: DE, DL, DNX	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: slow permeability.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	High: silty clay.
Doss: DS	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: moderately slow permeability.	Severe: seepage.	Moderate: moderately slow permeability; caliche in backfill area.	Severe: clay	Severe: clay	Severe: clay	Severe: clay	High: clay.
Frio: FR	Moderate: moderate shrink-swell potential; hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: moderately slow permeability.	Slight	Severe: hazard of flooding; silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	High: silty clay; resistivity.
Houston Black: HO	Severe: very high shrink-swell potential; poor traffic-supporting capacity.	Severe: very high shrink-swell potential.	Severe: very high shrink-swell potential.	Severe: very slow permeability.	Slight	Severe: clay	Severe: clay; very slow permeability.	Severe: clay	Severe: clay	Severe: clay; very slow permeability.	Very high: clay.
Karnes: KA	Moderate: fair traffic-supporting capacity.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability.	Severe: moderately rapid permeability; hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Moderate: hazard of flooding.	Severe: hazard of flooding.	Moderate: conductivity.
Krum: KM, KN, KNX For Denton part of KNX, see Denton series.	Severe: high shrink-swell potential; poor traffic-supporting capacity.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: moderately slow permeability.	Slight where slope is 1 to 3 percent. Moderate where slope is 3 to 5 percent.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	High: silty clay.
Nuvalde: NO, NV	Severe: poor traffic-supporting capacity.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: moderate permeability.	Moderate: moderate permeability.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	Severe: silty clay.	High: silty clay.
Ortif: OKX For Karnes part, see that series.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding; rapid permeability.	Severe: coarse fragments; rapid permeability.	Severe: hazard of flooding; rapid permeability.	Severe: hazard of flooding.	Moderate: hazard of flooding.	Moderate: hazard of flooding.	Severe: hazard of flooding.	Moderate: conductivity.
Rock outcrop. Too variable to be rated.											
Spires: SPX	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: high shrink-swell potential; bedrock at a depth of 21 to 38 inches.	Severe: high shrink-swell potential.	Severe: slow permeability; bedrock at a depth of 21 to 38 inches.	Severe: bedrock at a depth of 21 to 38 inches.	Severe: bedrock at a depth of 21 to 38 inches.	Moderate: slow permeability.	Slight	Slight	Moderate: slow permeability.	High: resistivity; clay.
Tarrant: TBK, TDK, TEK, TFK For the Bracket part of TBK, Doss part of TDK and Rock outcrop part of TEK and TFK, see Bracket, and Doss series and Rock outcrop.	Severe: bedrock at a depth of 5 to 14 inches; high shrink-swell potential; slopes of 15 to 45 percent.	Severe: bedrock at a depth of 5 to 14 inches; high shrink-swell potential; slopes of 15 to 45 percent.	Severe: bedrock at a depth of 5 to 14 inches; slopes of 1 to 45 percent; high shrink-swell potential.	Severe: bedrock at a depth of 5 to 14 inches.	Severe: bedrock at a depth of 5 to 14 inches.	Severe: bedrock at a depth of 5 to 14 inches.	Severe: very cobbly clay.	Severe: very cobbly clay.	Severe: very cobbly clay.	Severe: very cobbly clay; bedrock at a depth of 5 to 14 inches.	High: very cobbly clay.

Table 8.—Classification of soil series.

Series	Family	Subgroup	Order
Anhalt	Very fine, montmorillonitic, thermic	Udic Chromusterts	Vertisols.
Brackett	Loamy, carbonatic, thermic, shallow	Typic Ustochrepts	Inceptisols.
Denton	Fine, montmorillonitic, thermic	Vertic Calciustolls	Mollisols.
Doss	Clayey, carbonatic, thermic, shallow	Typic Calciustolls	Mollisols.
Frio[1]	Fine, mixed, thermic	Cumulic Haplustolls	Mollisols.
Houston Black	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Karnes	Coarse-loamy, carbonatic, thermic	Typic Ustochrepts	Inceptisols.
Krum	Fine, mixed, thermic	Vertic Haplustolls	Mollisols.
Nuvalde	Fine, mixed, thermic	Typic Calciustolls	Mollisols.
Orif	Sandy-skeletal, carbonatic, thermic	Typic Ustifluvents	Entisols.
Spires	Fine, mixed, thermic	Rhodic Paleustalfs	Alfisols.
Tarrant	Clayey-skeletal, montmorillonitic, thermic	Lithic Calciustolls	Mollisols.

[1] Frio series in Bandera County are taxadjuncts to the series for which they are named because the A1 horizon is very dark gray (10YR 3/1) and black (10YR 2/1) and is outside the series range. Use and management are similar.

Table 9.—Temperature and precipitation data.

Month	Temperature				Precipitation									Average number of days when precipitation is—			Snow, sleet	
	Average daily maximum	Average daily minimum	Average monthly highest maximum	Average monthly lowest minimum	Average total	Probability, in percent, of receiving—											Average total	Maximum amount	Maximum depth
						0 or trace	0.5 inch or more	1 inch or more	2 inches or more	3 inches or more	4 inches or more	5 inches or more	6 inches or more	0.1 inch or more	0.5 inch or more	1 inch or more			
	°F.	°F.	°F.	°F.	*Inches*												*Inches*	*Inches*	*Inches*
January	60.1	32.3	78.2	15.0	1.69	(1)	80	55	30	20	8	5	1	4	1	(1)	0.5	6.0	(1)
February	63.6	35.9	82.0	17.9	1.77	(1)	80	60	30	15	5	3	1	5	1	1	.5	8.0	1
March	70.8	41.3	87.7	23.1	1.68	2	80	69	30	15	7	4	1	5	1	(1)	.2	5.0	5
April	77.9	50.6	91.8	31.9	2.65	(1)	90	79	59	30	20	10	1	4	2		0	0	0
May	83.6	59.4	93.1	44.3	4.39	(1)	99	93	75	55	40	25	8	5	2	1	0	0	0
June	90.3	66.1	97.2	54.5	3.02	(1)	96	72	52	32	22	15	10	6	2	1	0	0	0
July	93.1	67.7	100.2	61.3	2.55	1	80	62	40	23	13	10	3	4	2	1	0	0	0
August	94.7	67.9	101.6	59.5	2.06	1	74	57	35	20	15	8	5	3	1	(1)	0	0	0
September	88.8	61.9	98.3	47.8	2.70	(1)	89	70	60	45	30	25	20	4	2	1	0	0	0
October	80.4	51.9	90.9	35.3	2.60	4	80	80	45	30	29	17	10	6	2	1	0	0	0
November	68.2	40.5	82.9	22.6	1.28	1	70	55	39	7	3	(1)	(1)	5	1	1	.1	3.5	1
December	62.5	33.6	78.3	18.3	1.88	3	80	60	40	29	10	4	2	5	1	1	(1)	1.3	0
Year	77.9	50.7			28.82									55	19	8	1.3	8.0	5

[1] Less than 1 percent.
[2] Less than ½ day.
[3] Trace, an amount too small to measure.
[4] Less than ½ inch.

NRCS Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at helpdesk@helpdesk.itc.nrcs.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

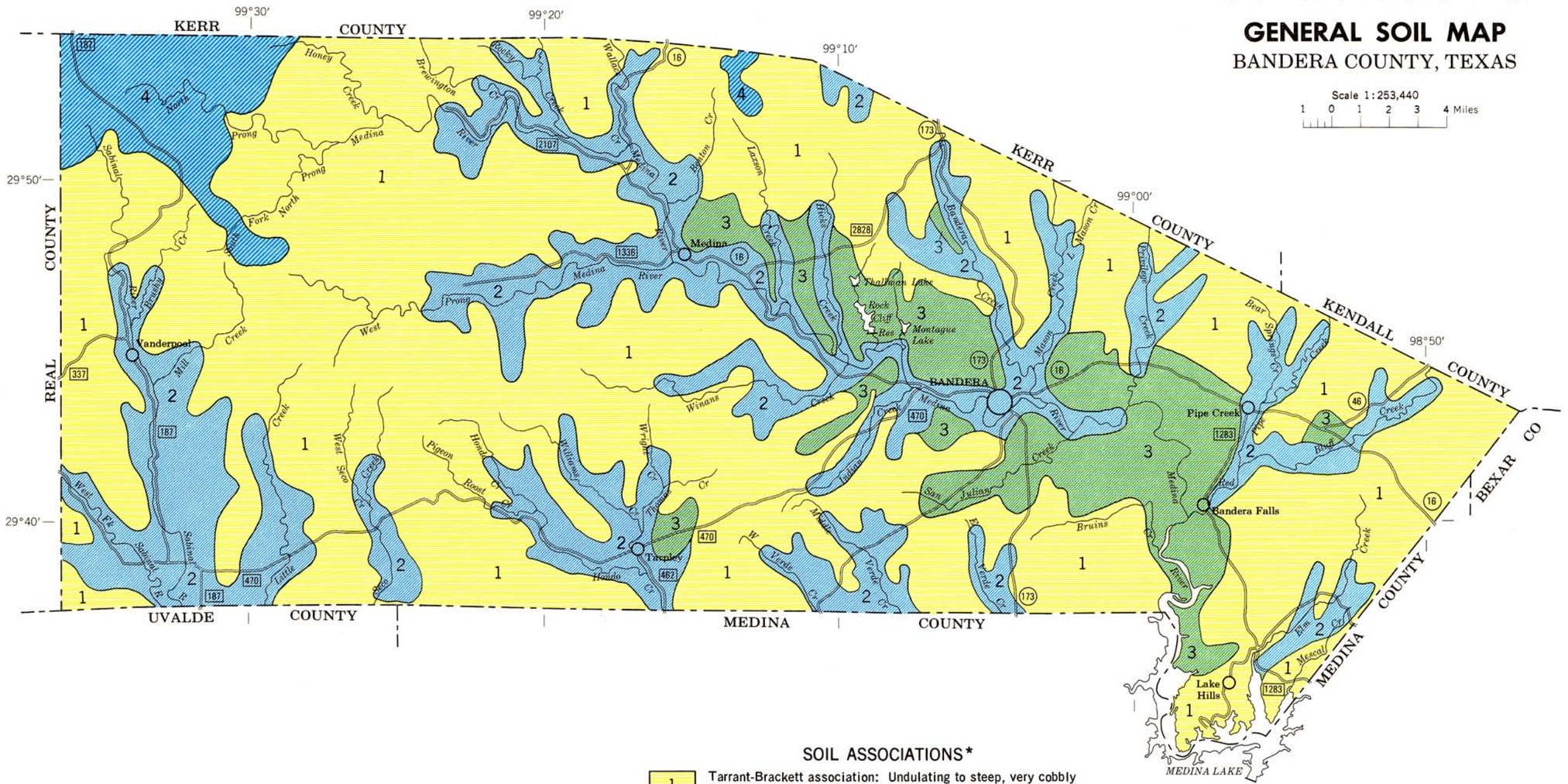
GENERAL SOIL MAP

BANDERA COUNTY, TEXAS

Scale 1:253,440

1 0 1 2 3 4 Miles

N



SOIL ASSOCIATIONS*

1 — Tarrant-Brackett association: Undulating to steep, very cobbly clayey to loamy, shallow to very shallow soils; on uplands

2 — Frio-Krum-Nuvalde association: Nearly level to gently sloping, clayey, deep soils; on bottom lands and terraces and in valleys

3 — Anhalt-Denton association: Nearly level to gently sloping, clayey, moderately deep soils; on uplands

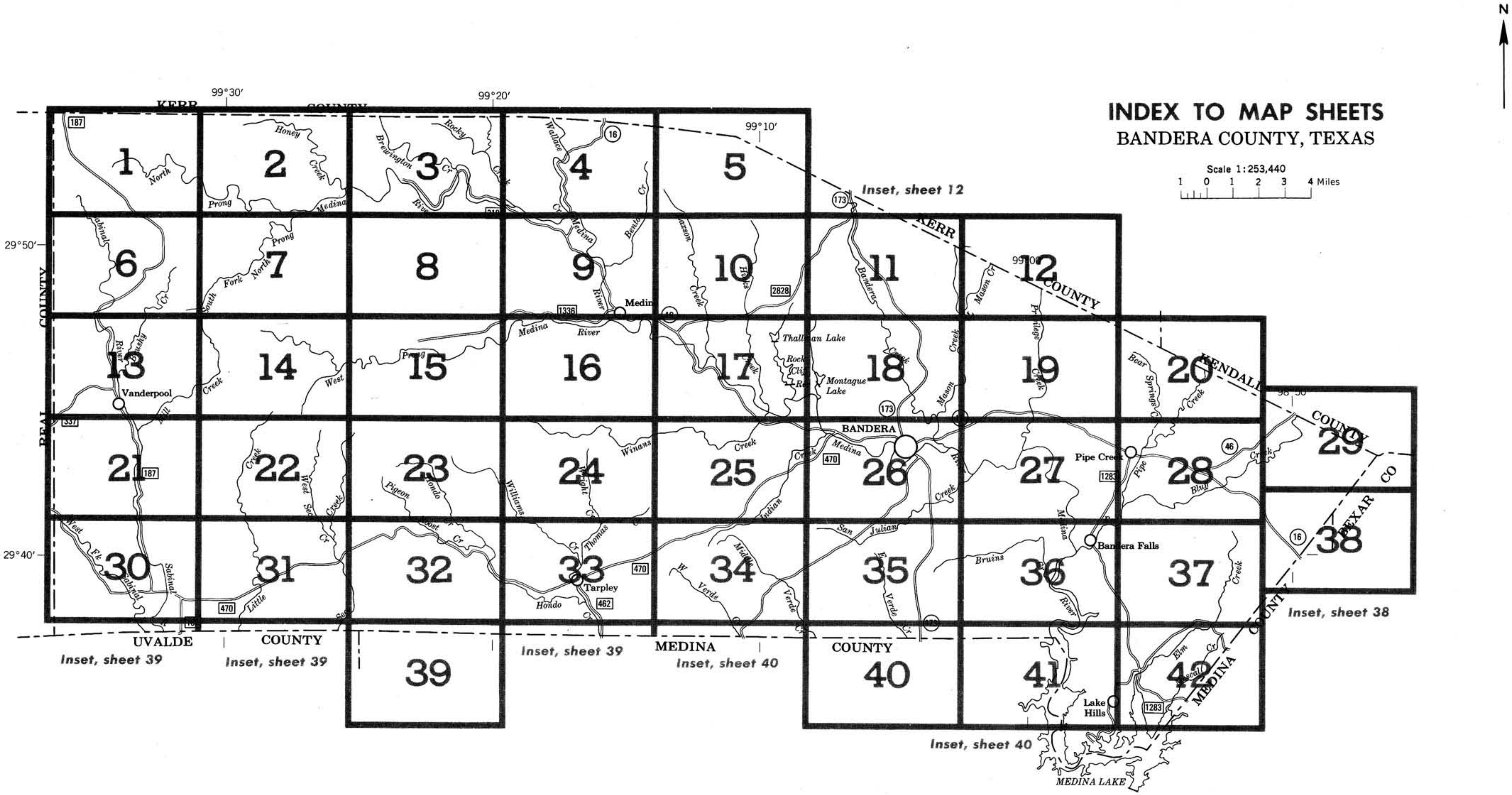
4 — Spires-Tarrant association: Gently undulating to undulating, loamy to very cobbly clayey, very shallow to moderately deep soils; on uplands

*Textures refer to the surface layer of the major soils.

Compiled 1975

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS
BANDERA COUNTY, TEXAS



SOIL LEGEND

Each soil symbol consists of two or three letters; for example, AN or BKX. The third letter X indicates that the delineations generally are larger and the composition of the mapping unit is more variable than that of other mapping units in this county.

SYMBOL	NAME
	MEDIUM INTENSITY MAP UNITS
AN	Anhalt clay, 0 to 2 percent slopes
DE	Denton silty clay, 1 to 3 percent slopes
DL	Denton silty clay, 3 to 5 percent slopes
DS	Doss clay, 1 to 5 percent slopes
FR	Frio silty clay
HO	Houston Black clay
KA	Karnes fine sandy loam, 1 to 3 percent slopes
KM	Krum silty clay, 1 to 3 percent slopes
KN	Krum silty clay, 3 to 5 percent slopes
ND	Nuvalde silty clay, 0 to 1 percent slopes
NV	Nuvalde silty clay, 1 to 3 percent slopes
	LOW INTENSITY MAP UNITS *
BKX	Brackett association, undulating
BRX	Brackett-Rock outcrop association, hilly
DNX	Denton association, undulating
KRX	Krum-Denton association, gently undulating
OKX	Orif-Karnes association, frequently flooded
SPX	Spires association, gently undulating
TBX	Tarrant-Brackett association, steep
TDX	Tarrant-Doss association, undulating
TRX	Tarrant-Rock outcrop, association, undulating
TSX	Tarrant-Rock outcrop, association, steep

* The delineations are much larger and the composition of these units is more variable than other map units in the county. Mapping has been controlled well enough, however, for the anticipated use of the areas involved.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State, farm or ranch

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit (G.P.)

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

BANDERA COUNTY, TEXAS — SHEET NUMBER 1

1 810 000 FEET

INDEFINITE BOUNDARY

KERR COUNTY

REAL COUNTY

1 750 000 FEET

Frio Draw

Well Hollow

Prong Medina River

North

SPX TRX TSX

187

(Joins sheet 6)

1 835 000 FEET

(Joins sheet 2)

1 735 000 FEET

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000 5 000

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS — SHEET NUMBER 2

KERR COUNTY

INDEFINITE BOUNDARY

1 865 000 FEET

750 000 FEET

735 000 FEET

1 840 000 FEET

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 7)

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

SPX TRX TSX AN KRX KM

Honey Creek

Buckeye Creek

North Prong

Medina River

Slaughter Hollow

Covy Hollow

Cold Hollow

Shepherd Creek

Little Shepherd Creek

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 2

③

N

2 Miles
1
0
¼
½
¾
1

Feet
10 000
5 000
0
1 000
2 000
3 000
4 000
5 000

BANDERA COUNTY, TEXAS NO. 3

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS — SHEET NUMBER 4

(4)

N

2 Miles — 10 000 Feet — 5 000 — 0

1 — ¼ — ½ — ¾ — 1

5 000 — 4 000 — 3 000 — 2 000 — 1 000 — 0

1 925 000 FEET

750 000 FEET

735 000 FEET

1 900 000 FEET

INDEFINITE BOUNDARY

KERR COUNTY

Johnson Creek

Wallace Creek

Robinson Creek

The Bluff

Chalk Creek

Bonton Creek

Rocky Creek

North Prong Medina River

FR 16

FR 2107

FR 18

TSX TBX TRX KRX KM KN FR TDX SPX BKX DL ND BRX NV KA AN OKX

(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 9)

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 4

BANDERA COUNTY, TEXAS — SHEET NUMBER 5

BANDERA COUNTY, TEXAS NO. 5

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 930 000 FEET

750 000 FEET

KERR COUNTY

INDEFINITE BOUNDARY

Hog Branch

Palmer Branch

Hollow

Verde Creek

KM Creek

Crow Canyon

Prison Canyon

(Joins sheet 4)

(Joins sheet 10)

1 955 000 FEET

735 000 FEET

(Joins inset, sheet 12)

N

2 Miles 1

10 000 Feet 5 000

0 1 000 2 000 3 000 4 000 5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 6

(6)

(Joins sheet 1)

1 835 000 FEET

730 000 FEET

(Joins sheet 7)

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

REAL COUNTY

Sabinal River

Can Creek

Dry Creek

CANYON

Ranger Creek

Snow Creek

Wedgeworth Creek

Brushy Creek

Evans Creek

SABINAL

187

TSX TRX SPX OKX KRX KN AN

715 000 FEET

1 810 000 FEET

(Joins sheet 13)

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 6

BANDERA COUNTY, TEXAS — SHEET NUMBER 7

BANDERA COUNTY, TEXAS NO. 7

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 840 000 FEET

(Joins sheet 2)

1 730 000 FEET

(Joins sheet 6)

(Joins sheet 8)

(Joins sheet 14)

1 715 000 FEET

1 865 000 FEET

7

N

2 Miles

10 000 Feet

1

5 000

0

1 000

¼

2 000

½

3 000

¾

4 000

1

5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 8

(8)

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

(Joins sheet 3)

1 895 000 FEET

730 000 FEET

(Joins sheet 7)

(Joins sheet 9)

715 000 FEET

1 870 000 FEET

(Joins sheet 15)

Hand Horse Creek

Right Hand Horse Creek

Left Hand Horse Creek

Mickle Creek

Pecan Creek

Board Tree Hollow

Elam Creek

Rock Chimney Ranch

Bauerlein Creek

Stanford Creek

Rhume Creek

TSX TRX KRX KN AN ND TBX BRX

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 8

BANDERA COUNTY, TEXAS NO. 9

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(10)

BANDERA COUNTY, TEXAS — SHEET NUMBER 10

N

2 Miles 1

10 000 Feet 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

1 5 000

(Joins sheet 5)

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 17)

1 955 000 FEET

730 000 FEET

715 000 FEET

1 930 000 FEET

Kirk Creek

Laxson Creek

Hicks Creek

Myrtle Creek

Spring Creek

2828

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 10

BANDERA COUNTY, TEXAS — SHEET NUMBER 11

11

BANDERA COUNTY, TEXAS NO. 11

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 960 000 FEET

730 000 FEET

(Joins inset, sheet 12)

(Joins sheet 10)

(Joins sheet 18)

(Joins sheet 12)

1 985 000 FEET

715 000 FEET

N

2 Miles

10 000 Feet

5 000

Sugarloaf Hill

Sunset Mountain

Duffys Mountain

Mount Medina

KERR COUNTY

INDEFINITE BOUNDARY

Bandera Creek

Myrtle Creek

Mason Creek

2828

173

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

2 015 000 FEET

1 975 000 FEET

730 000 FEET

740 000 FEET

735 000 FEET

715 000 FEET

1 960 000 FEET

1 990 000 FEET

(Joins sheet 5)

(Joins sheet 11)

(Joins sheet 11)

(Joins sheet 19)

KERR COUNTY

INDEFINITE BOUNDARY

Bandera Pass

Langford Mountain

Mico Cr.

Creek

Mason

Little

Cloud Hollow

TBX TRX BKX BRX KN TDX AN FR DE KRX KM DNX

173

2828

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 12

BANDERA COUNTY, TEXAS — SHEET NUMBER 13

BANDERA COUNTY, TEXAS NO. 13

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 810 000 FEET

710 000 FEET

695 000 FEET

1 835 000 FEET

(Joins sheet 6)

(Joins sheet 14)

(Joins sheet 21)

REAL COUNTY

Hunter Creek

Sabinal River

Dry Sabinal Creek

North Prong

Middle Prong

Fiddler Hollow

Jernigan

Massey Hollow

Vanderpool

Helaez Lake

Evans Creek

Mill Creek

187

337

KRX TRX TSX OKX KN KM TBX TDX FR AN HO DL

13

N

2 Miles 1 10 000 Feet 1 5 000

0 1/4 1/2 3/4 1 0 1 000 2 000 3 000 4 000 5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 14

(14)

N

2 Miles 1

10 000 Feet 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

(Joins sheet 7)

1 865 000 FEET

710 000 FEET

(Joins sheet 13)

695 000 FEET

1 840 000 FEET

(Joins sheet 22)

(Joins sheet 15)

Mill Creek

Druken Creek

Creek

Cranks Creek

Clark

Love Creek

Duncan Creek

West Prong Medina River

Hollow

Hand Right Branch

Hand Left Branch

Willow Mill Creek

Spring Branch

Negro Hollow

Raven Roost Hollow

Anderson

Dockery

TRX

TSX

SPX

KRX

KM

KN

AN

DS

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 14

BANDERA COUNTY, TEXAS — SHEET NUMBER 15

15

N

BANDERA COUNTY, TEXAS NO. 15

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 870 000 FEET

710 000 FEET

(Joins sheet 8)

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 23)

695 000 FEET

1 895 000 FEET

2 Miles
1
0

10 000 Feet
5 000
0

1 000
2 000
3 000
4 000
5 000

¼
½
¾
1

BANDERA COUNTY, TEXAS — SHEET NUMBER 16

(16)

N

2 Miles 1

10 000 Feet 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

(Joins sheet 9)

1 925 000 FEET

710 000 FEET

695 000 FEET

1 900 000 FEET

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 24)

Medina

Rocky River Ranch

A Bar A Ranch

Stanford Cr.

Prong

West

River

Creek

Coalkiln

Elm

Wet Hollow

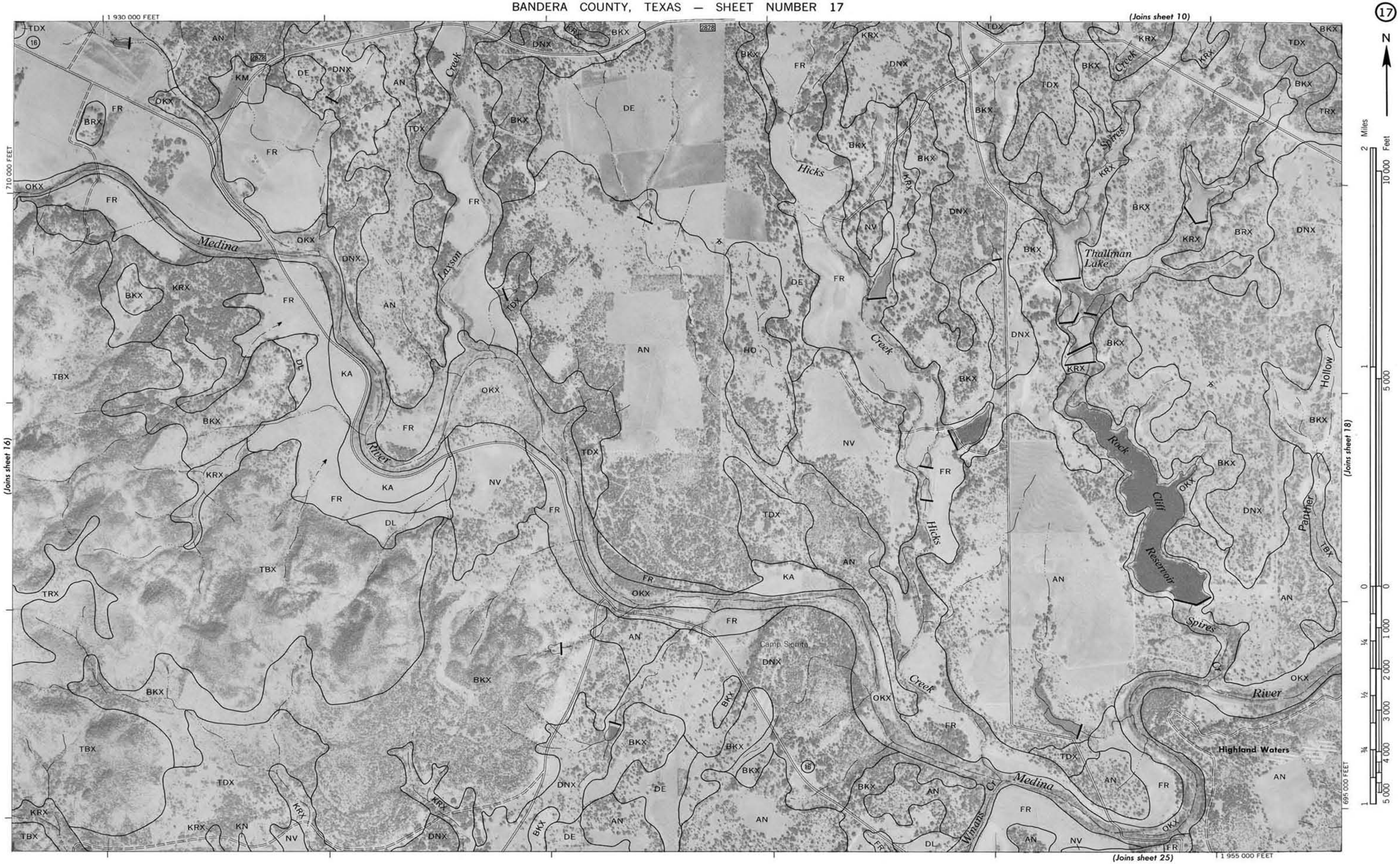
Walker

TBX TDX TRX TSX BKX BRX DNX DL DS DE FR KA KM KN KRX NV OKX AN

1336 1338

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

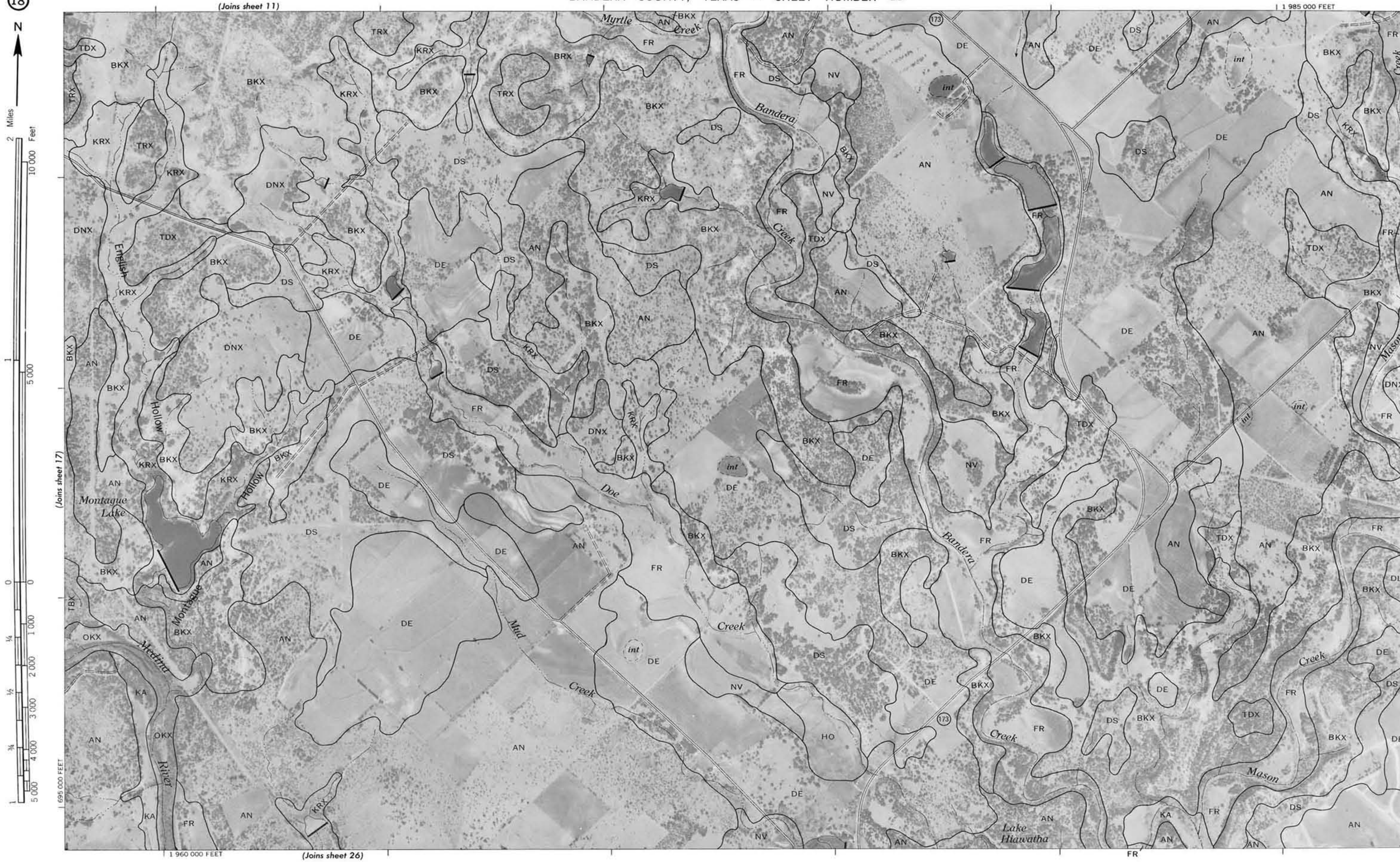
BANDERA COUNTY, TEXAS NO. 16



BANDERA COUNTY, TEXAS NO. 17

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS — SHEET NUMBER 18



This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 18

BANDERA COUNTY, TEXAS — SHEET NUMBER 19

19

BANDERA COUNTY, TEXAS NO. 19

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 990 000 FEET

710 000 FEET

(Joins sheet 12)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 27)

695 000 FEET

2 015 000 FEET

KERR CO
(INDEFINITE BOUNDARY)

Polly Peak

Purple Sage Ranch

Mason

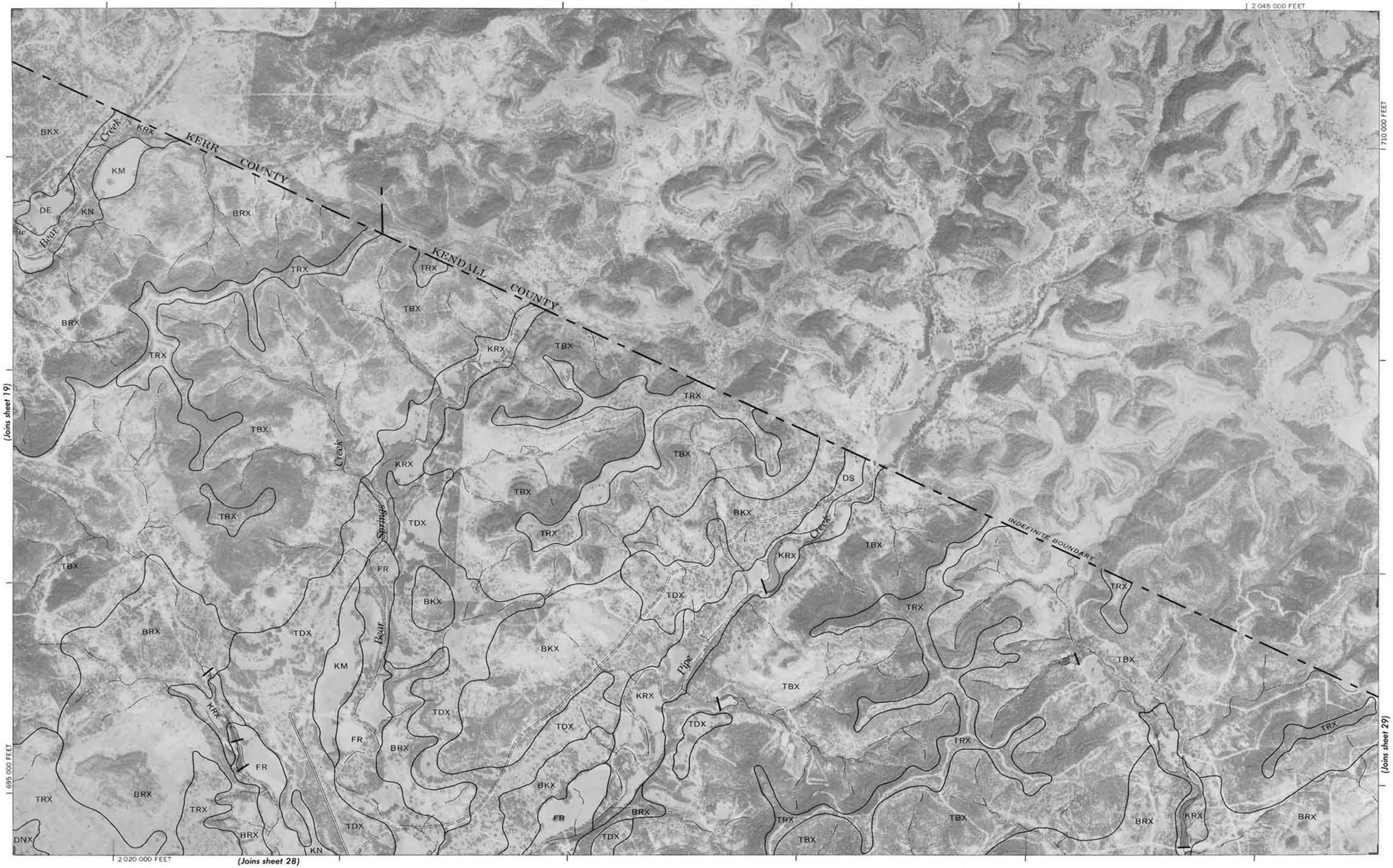
Creek

Bear Creek

Privilege Creek

N

2 Miles
10 000 Feet
1
5 000
0
0
¼
1 000
½
2 000
¾
3 000
1
4 000
1
5 000



N

2 Miles 1 0

10 000 Feet 5 000 0

¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 20

BANDERA COUNTY, TEXAS — SHEET NUMBER 21

21

N

BANDERA COUNTY, TEXAS NO. 21

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 810 000 FEET

690 000 FEET

675 000 FEET

1 835 000 FEET

(Joins sheet 13)

(Joins sheet 22)

(Joins sheet 30)

REAL COUNTY

337

187

Sabinal River

Mill Creek

West Fork

2 Miles

10 000 Feet

5 000

1

0

1/4

1 000

2 000

1/2

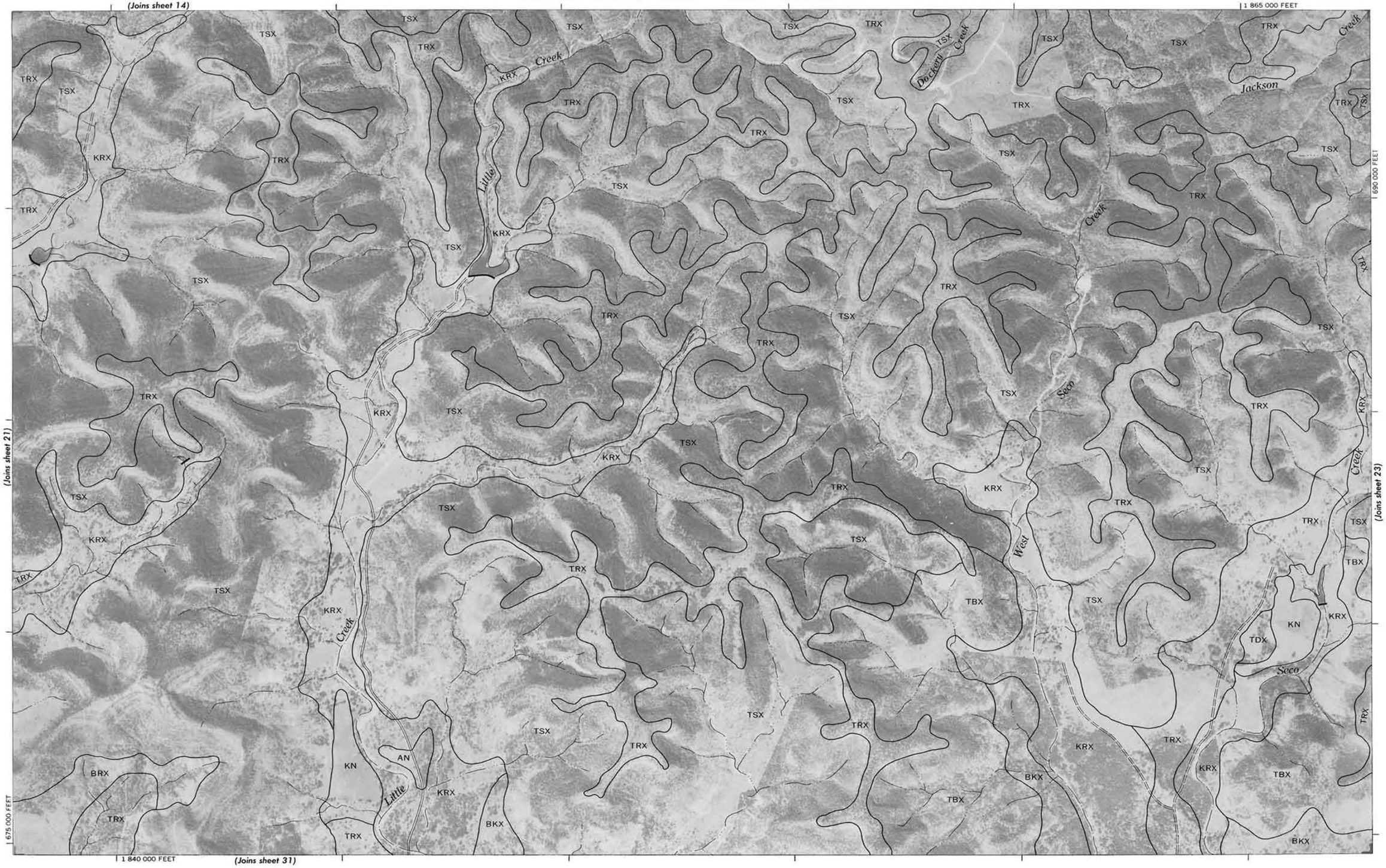
3 000

3/4

4 000

1

5 000



N

2 Miles — 10 000 Feet — 5 000

1 — ¼ — ½ — ¾ — 1

0 — 1 000 — 2 000 — 3 000 — 4 000 — 5 000

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 22

BANDERA COUNTY, TEXAS — SHEET NUMBER 23

BANDERA COUNTY, TEXAS NO. 23

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 870 000 FEET

690 000 FEET

(Joins sheet 15)

(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 32)

1 895 000 FEET

675 000 FEET

Townsend

Camp

Hollow

Round Mountain

Creek

Blunt

Hollow

Carpenter Creek

Light

Creek

Rule

Creek

Cazey

Hondo

Creek

Williams

Creek

Pigeon

Roost

Creek

Hondo

Creek

Buck

Hollow

Creek

Creek

Creek

KM

Creek

TSX

TRX

KRX

SPX

BRX

BKX

TDX

TBX

FR

DNX

23

N

2 Miles

1

10 000 Feet

5 000

0

0

1/4

1 000

2 000

1/2

3 000

3/4

4 000

1

5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 24

N

2 Miles 1

10 000 Feet 5 000

0 1 000 2 000 3 000 4 000 5 000 Feet

0 ¼ ½ ¾ 1

(Joins sheet 16)

(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 33)

1 925 000 FEET

690 000 FEET

675 000 FEET

1 900 000 FEET

Rule Creek

Winans Creek

Canyon Creek

Elam Creek

Simpson Creek

Padgett Creek

Monroe Hollow

Wright Hollow

Deathwood Hollow

Bishop Hollow

Williams Creek

Cedar Hollow

Thomas Creek

El Paraiso Ranch

Iron Top Mountain

Soto Mountain

Chalk Mountain

TRX TSX KRX TBX TDX KM KN BKX BRX DE FR AN NV DNX

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS - NO. 24

BANDERA COUNTY, TEXAS — SHEET NUMBER 25

BANDERA COUNTY, TEXAS NO. 25

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 930 000 FEET

1 690 000 FEET

1 675 000 FEET

1 955 000 FEET

(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 34)

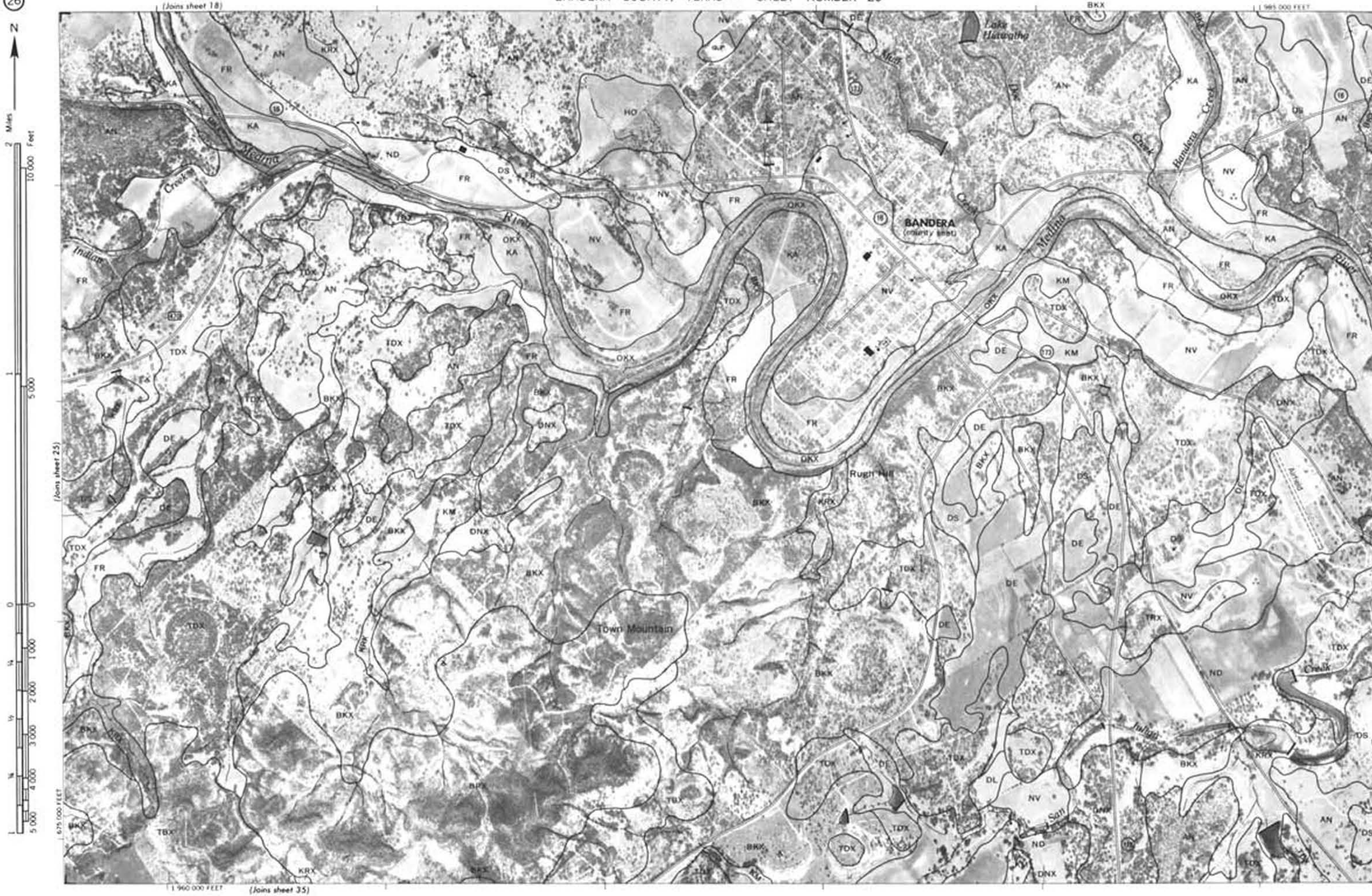
Winans Creek

Pugmore Creek

Indian Creek

2 Miles
10 000 Feet
1
5 000
0
0
1 000
¼
2 000
½
3 000
¾
4 000
1
5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 26



This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS — SHEET NUMBER 27

BANDERA COUNTY, TEXAS NO. 27

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 990 000 FEET

690 000 FEET

(Joins sheet 19)

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 36)

2 015 000 FEET

675 000 FEET

27

N

2 Miles

10 000 Feet

1

5 000

0

1 000

2 000

3 000

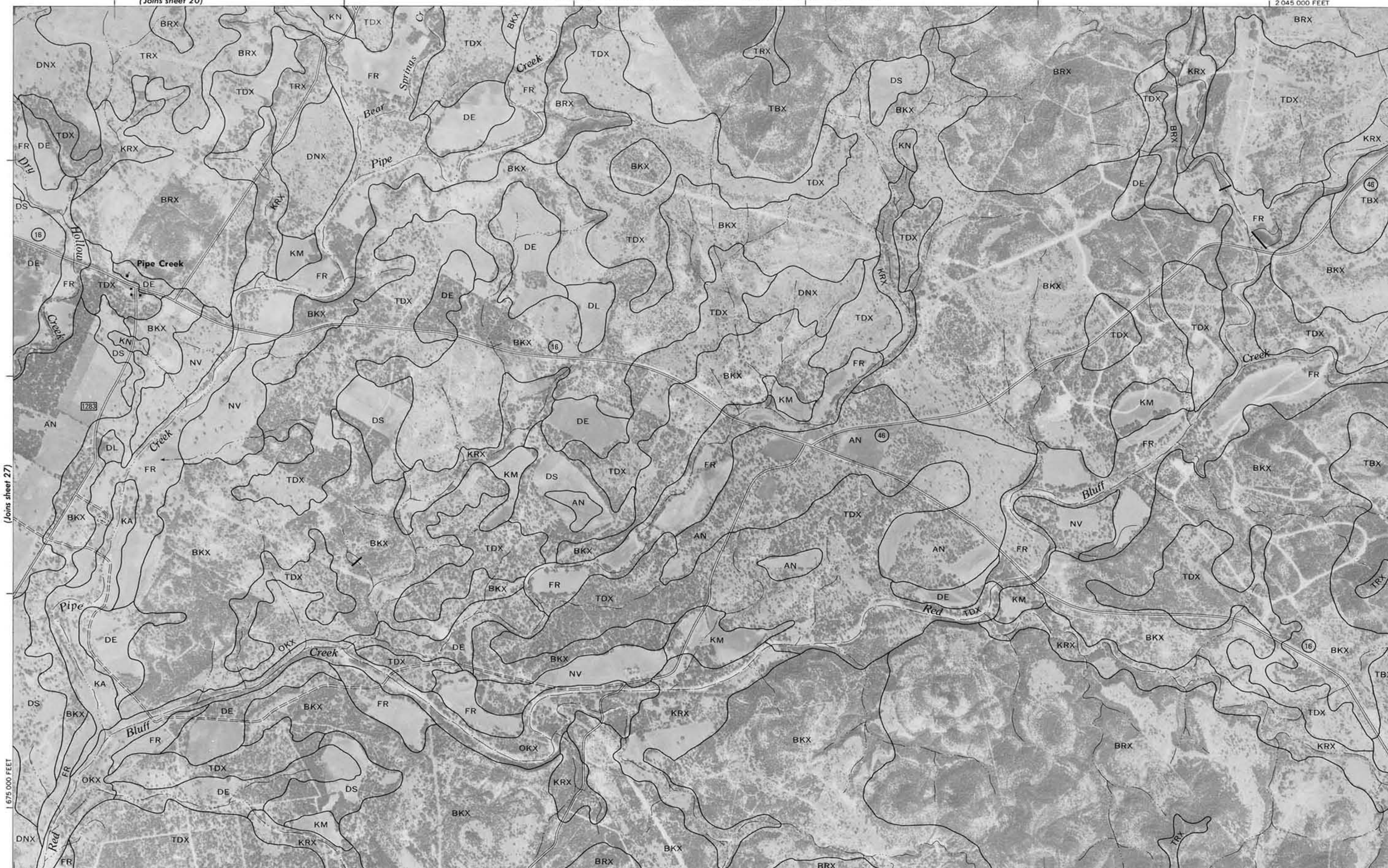
4 000

5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 28

(Joins sheet 20)

N



(Joins sheet 27)

(Joins sheet 38) | (29)

(Joins sheet 37)

2 Miles — 1 — 0 — ¼ — ½ — ¾ — 1

Feet: 10 000 — 5 000 — 0 — 1 000 — 2 000 — 3 000 — 4 000 — 5 000

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS — SHEET NUMBER 29

29

BANDERA COUNTY, TEXAS NO. 29

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 050 000 FEET

695 000 FEET

(Joins sheet 28) | (Joins sheet 20)

INDEFINITE BOUNDARY

KENDALL COUNTY

BEXAR COUNTY

PREVIOUSLY PUBLISHED BEXAR COUNTY BOUNDARY

Bluff Creek

Red Bluff

Balcones Creek

San Geronimo Ck.

TBX TDX BRX BKX KRX KN DL DS TRX

46

(Joins sheet 38)

2 075 000 FEET

680 000 FEET

N

2 Miles
1
0

10 000 Feet
5 000
0

1 000
2 000
3 000
4 000
5 000

30

BANDERA COUNTY, TEXAS — SHEET NUMBER 30

N

2 Miles 10 000 Feet

1 5 000

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

0 0

(Joins sheet 21)

1 835 000 FEET

670 000 FEET

655 000 FEET

1 810 000 FEET

(Joins inset B, sheet 39)

(Joins sheet 31)

REAL COUNTY

Sabinal River

West Fork Sabinal River

Sabinal River

Spring Branch

Sabinal River

187

470

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 30

BANDERA COUNTY, TEXAS NO. 31

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 840 000 FEET

670 000 FEET

655 000 FEET

1 865 000 FEET

(Joins sheet 30)

(Joins sheet 22)

(Joins sheet 32)

(Joins inset A, sheet 39)

Little Creek

Hay Hollow

West Seco Creek

Seco Creek

Hollow

Buck Seco Creek

Sentry Mountain

HABY CEMETERY

Braw Creek

Seco Cr

470

31

N

2 Miles

10 000 Feet

1

5 000

0

0

¼ 1 000

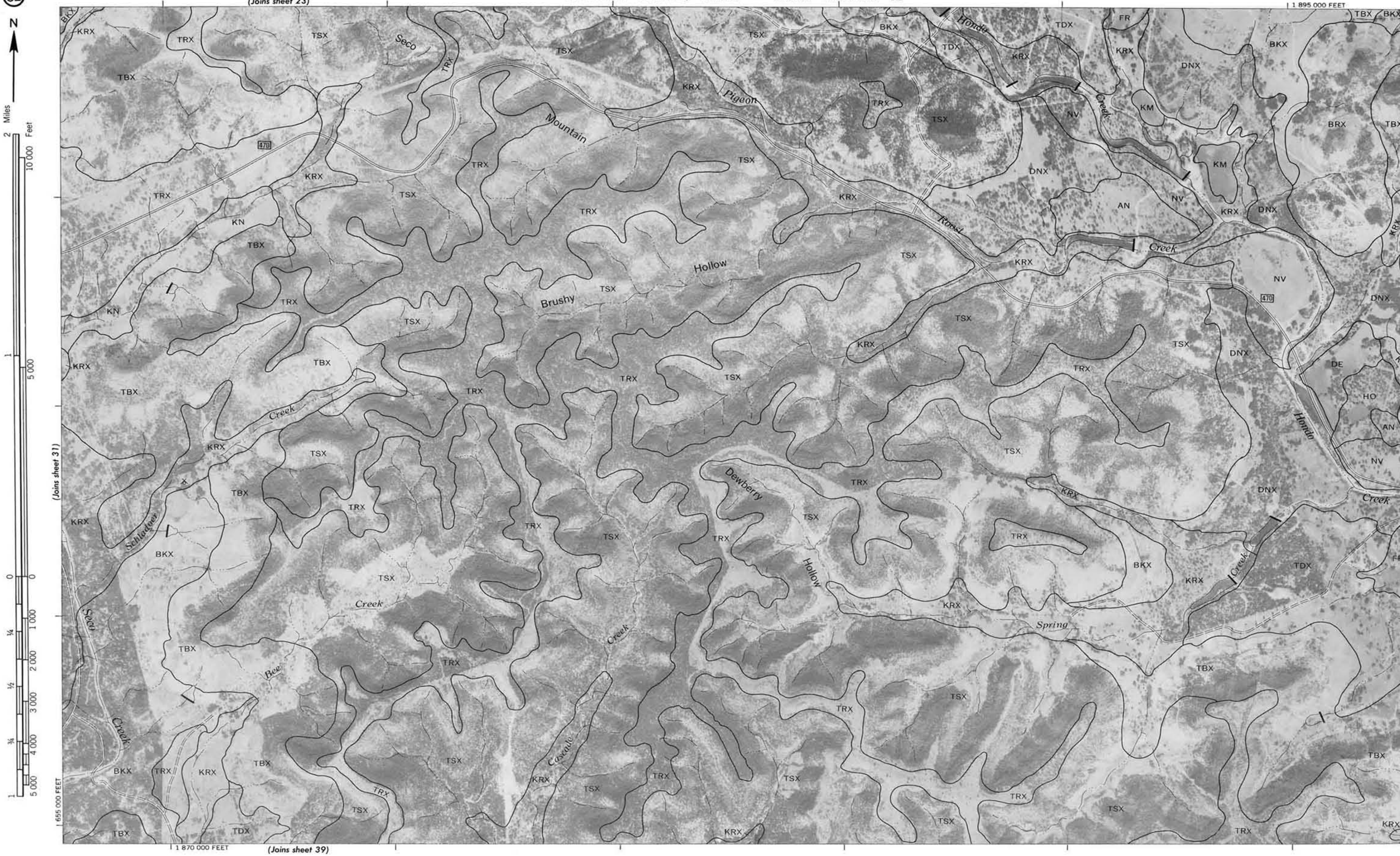
½ 2 000

¾ 3 000

1 4 000

1 5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 32



This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

1 900 000 FEET

670 000 FEET

(Joins sheet 24)

(Joins sheet 32)

(Joins sheet 34)

(Joins inset C, sheet 39)

1 925 000 FEET

1 655 000 FEET

Gunsight Mountain

Sugarloaf Mountain

Saddleback Mountain

Tarpley

TARPLEY CEMETERY

Williams Creek

Simpson Creek

Thomas Creek

Honda Creek

Commissioners Creek

Hay Hollow

G.P.

470

462

2 Miles

10 000 Feet

1

5 000

0

1 000

¼

2 000

½

3 000

¾

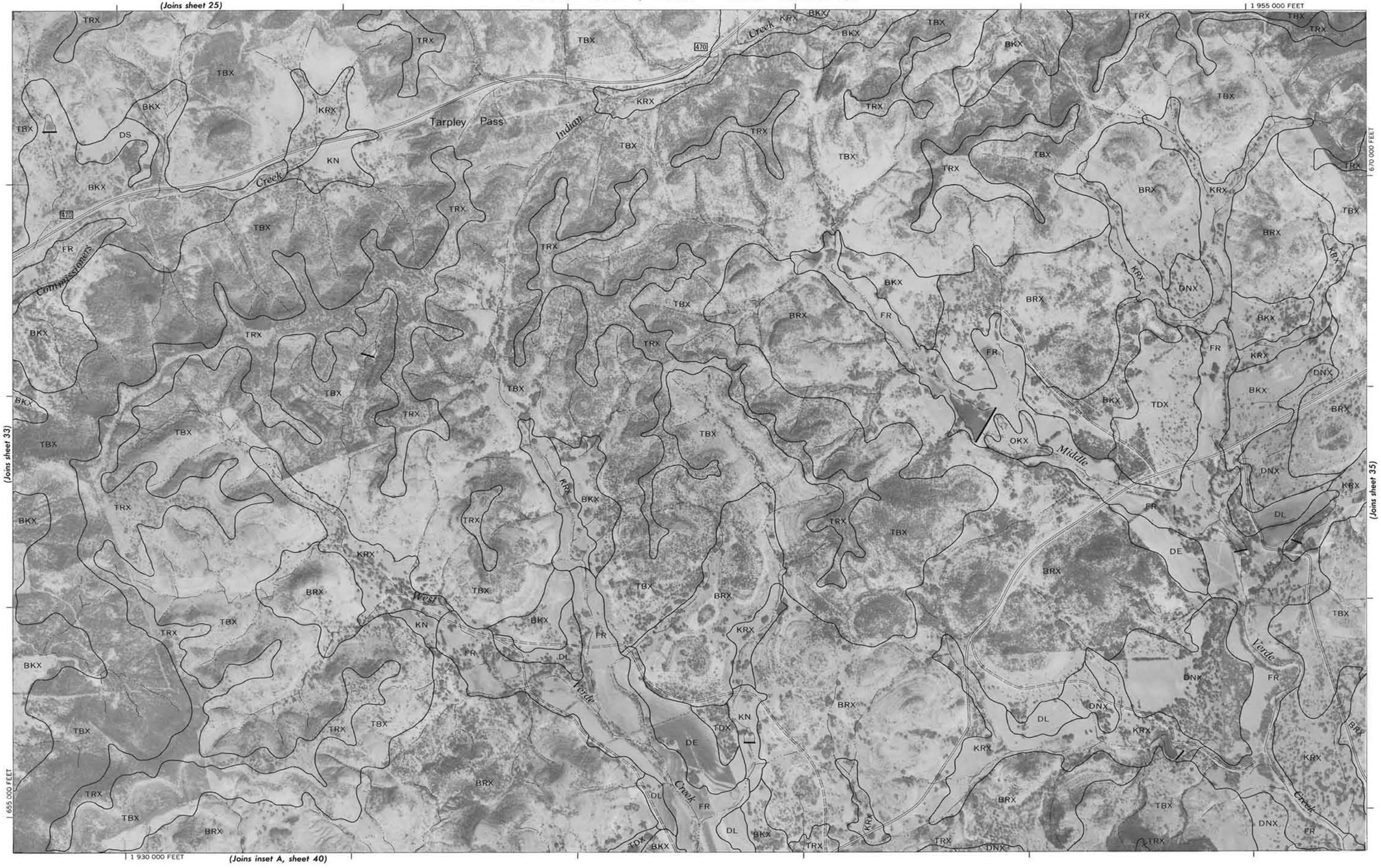
4 000

1

5 000

BANDERA COUNTY, TEXAS NO. 33

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

2 Miles 1

10 000 Feet 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 34

BANDERA COUNTY, TEXAS — SHEET NUMBER 35

BANDERA COUNTY, TEXAS NO. 35

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 960 000 FEET

1 670 000 FEET

1 655 000 FEET

1 985 000 FEET

(Joins sheet 34)

(Joins sheet 26)

(Joins sheet 36)

(Joins sheet 40)

35

N

2 Miles

10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

(36)

N

2 Miles 10 000 Feet

1 5 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000 5 000

(Joins sheet 27)

2 015 000 FEET

6 70 000 FEET

1 655 000 FEET

1 990 000 FEET

(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 41)

Barnes Branch Creek

Bruins Creek

Rocky Creek

Red Bluff Creek

Bandera Falls

Medina River

MEDINA RIVER

water

1283

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 36

BANDERA COUNTY, TEXAS — SHEET NUMBER 37

BANDERA COUNTY, TEXAS NO. 37

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2 020 000 FEET

670 000 FEET

(Joins sheet 28)

(Joins sheet 36)

(Joins sheet 42)

2 045 000 FEET

655 000 FEET

(Joins ins, 38) | (38)

MEDINA COUNTY

Creek

Elbar

1283

37

N

2 Miles

10 000 Feet

1 5 000

¼ 1 000

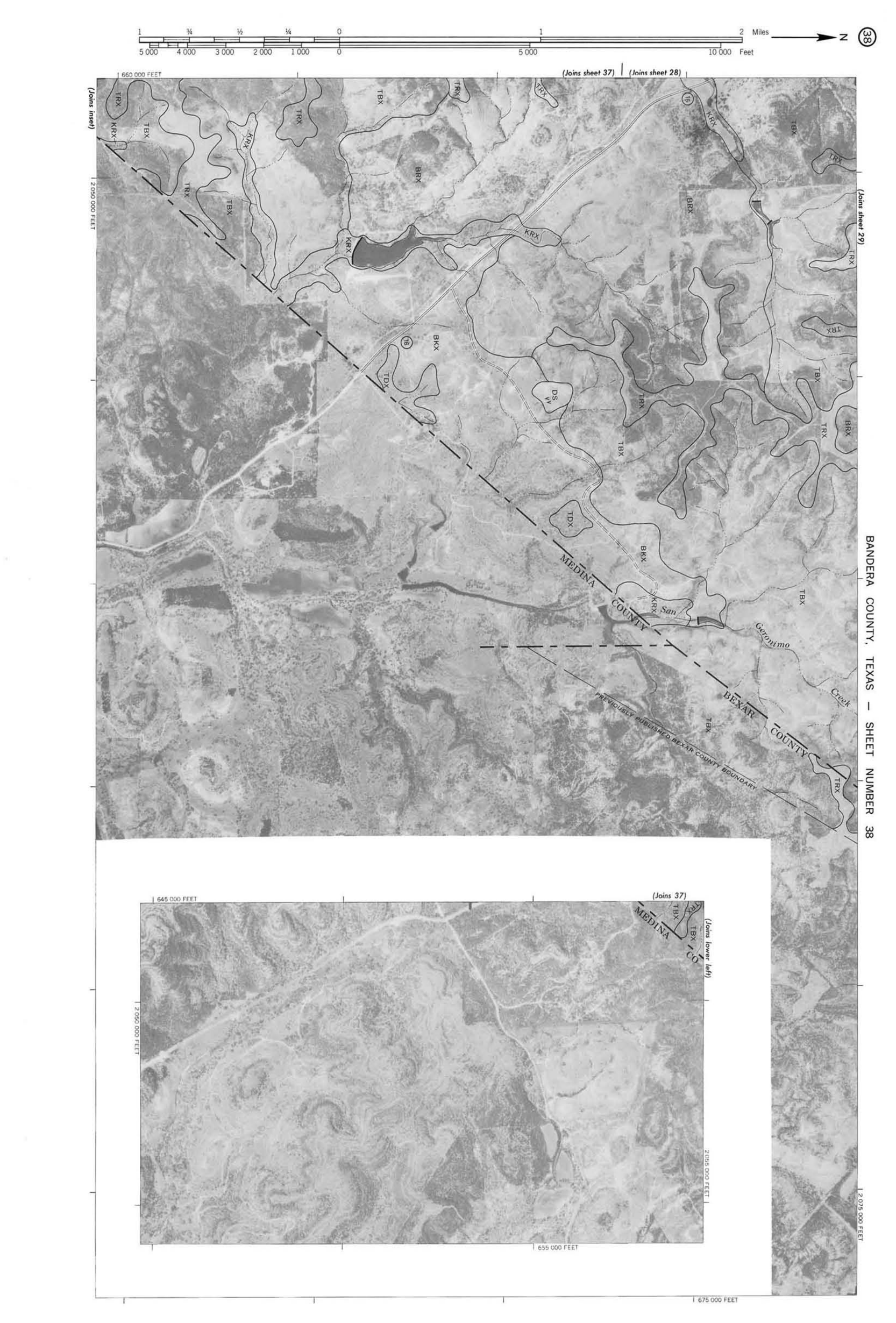
½ 2 000

¾ 3 000

1 4 000

0 0

1 5 000



BANDERA COUNTY, TEXAS — SHEET NUMBER 38

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 38

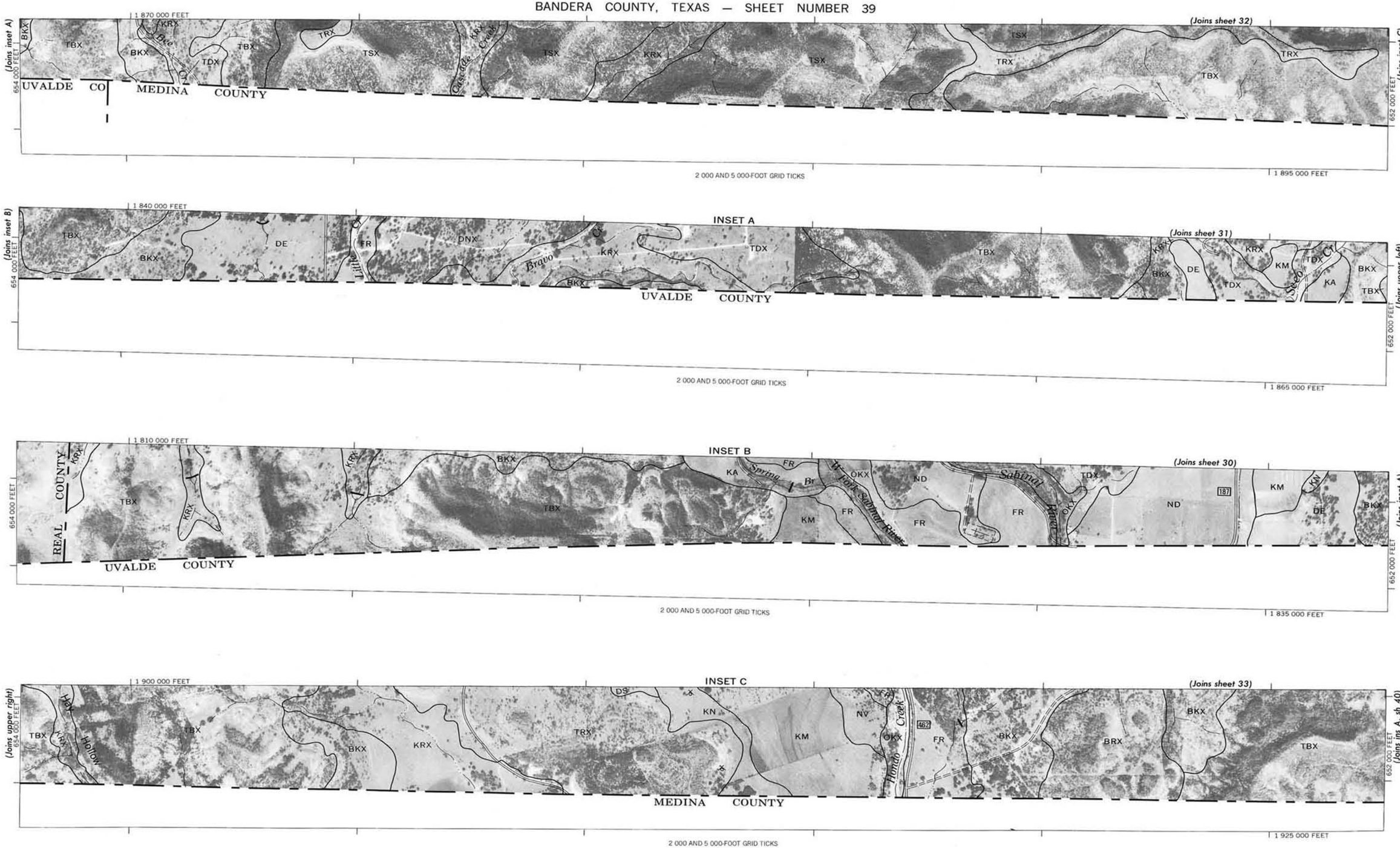
BANDERA COUNTY, TEXAS — SHEET NUMBER 39

39

N

BANDERA COUNTY, TEXAS NO. 39

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



(40)

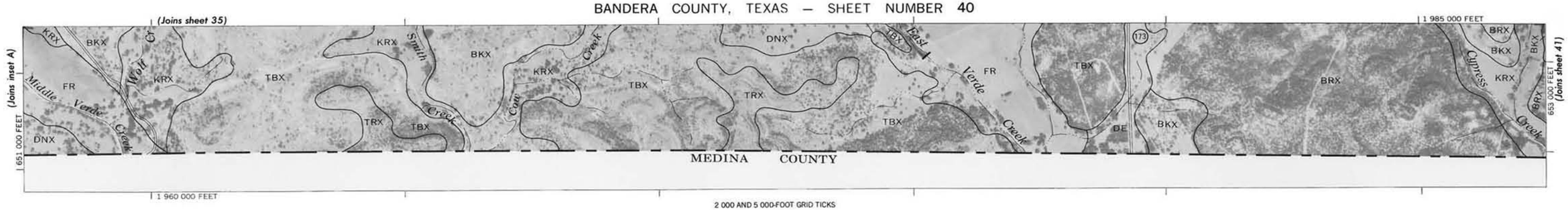
N

Miles 2 1 0

Feet 10 000 5 000 0

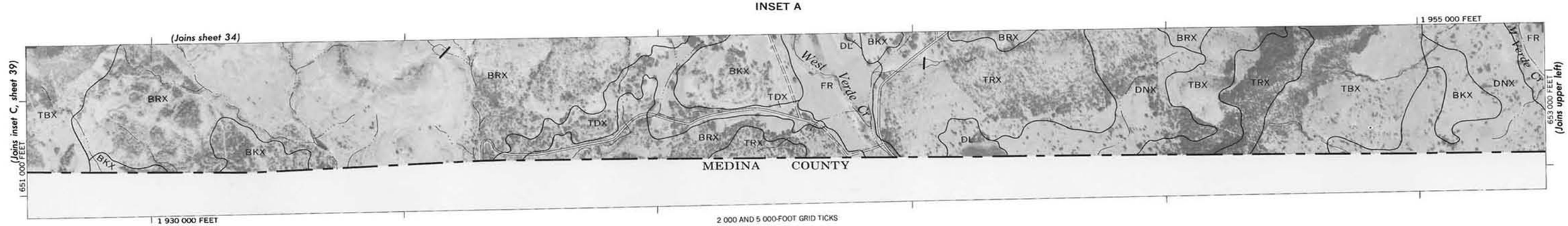
1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000 0



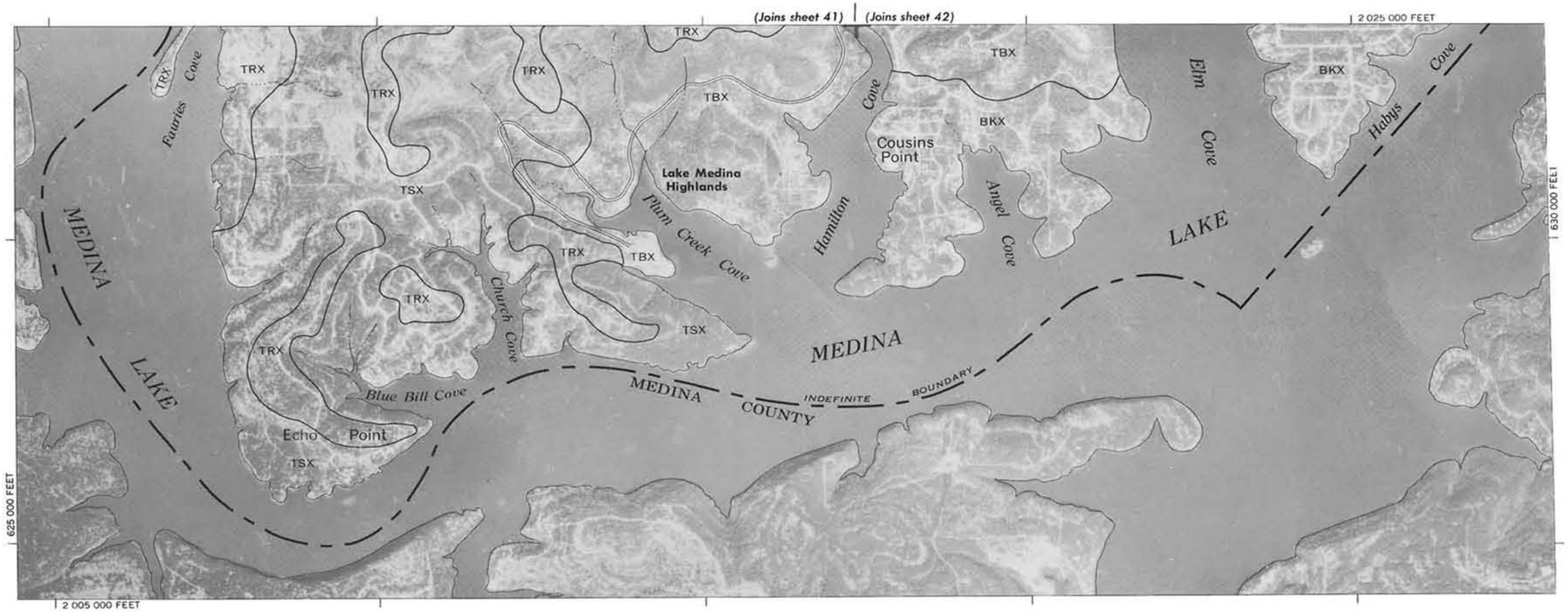
2 000 AND 5 000-FOOT GRID TICKS

INSET A



2 000 AND 5 000-FOOT GRID TICKS

INSET B



This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 40

BANDERA COUNTY, TEXAS — SHEET NUMBER 41

41

BANDERA COUNTY, TEXAS NO. 41

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 990 000 FEET

(Joins sheet 40)

1 650 000 FEET

(Joins sheet 36)

N

MEDINA COUNTY

MEDINA RIVER

MEDINA LAKE

INDEFINITE BOUNDARY

Liebold Mountain

Spettel Cove

Lake Hills

Goat Hill

Rocky Creek

Brushy Creek

KM

Joins sheet 42)

2 015 000 FEET

(Joins inset B, sheet 40)

2 Miles
10 000 Feet
1
5 000
0
0
1 000
¼
2 000
½
3 000
¾
4 000
1
5 000

BANDERA COUNTY, TEXAS — SHEET NUMBER 42

(42)

N

2 Miles 1 0

10 000 Feet 5 000 0

1 000 2 000 3 000 4 000 5 000

1 ½ ¼ 0 ¼ ½ ¾ 1

(Joins sheet 37)

(Joins sheet 41)

(Joins inset B, sheet 40)

2 045 000 FEET

650 000 FEET

635 000 FEET

2 020 000 FEET

TDX DS BRX BKX KRX DE FR TRX TBX NV

1283 1789

Creek Elm Creek Mescal

St Victors Chapel

Lake Hills

Elm Cove

MEDINA LAKE

Habys Cove

MEDINA COUNTY

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BANDERA COUNTY, TEXAS NO. 42